No. 20. 1911.

(UNIVERSITY OF LONDON.)

COUNTY COUNCILS OF KENT & SURREY.

THE JOURNAL

OF THE

South-Eastern Agricultural College,

WYE, KENT.

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GENERAL CONTENTS.

EDITORIAL NOTES.

Considerable progress has been made since the issue of the last number of the College *Journal* in the organization by the State of a definite scheme for Agricultural Education and Research, and although this progress has been commented on as somewhat slow, it is essential that a well-balanced permanent scheme be formulated which will not require a large amount of revision, as institutions will then be in a position to make their plans both for buildings, equipment and staff, to carry out their share of the work with a satisfactory prospect of continuity.

It would appear as though Wye College were the natural centre for a Research Institution for Fruit and Hop-growing, and this opinion is largely held by those engaged in the Fruit-growing industry as is shown by the fact that no less than 270 growers, representing 23,000 acres of Fruit, appended their names to the following petition which was presented to the President of the Board of Agriculture.

> "We, the undersigned Fruit-growers, learning that there is to be established in England a Research Institution for carrying out investigations in Fruit-growing, including the practical treatment of Plant Diseases, desire to urge upon the Board of Agriculture the very strong claims which Kent possesses for the establishment of such an Institution within its borders, as being the county containing the larger and more rapidly increasing acreage of fruit than any other county in the United Kingdom."

The Board have, only for the present it is hoped, decided that such an institution is not necessary in the S.E. of England, and have arranged for the establishment of a

Research Institution for Fruit-growing in the West of England by an extension of the National Fruit and Cider Institute at Long Ashton, Somerset, in connection with the University of Bristol, in which the beginning of an Agricultural Department has just been commenced. This decision of the Board will in no way affect the research activities of Wye College, and the scheme of investigation work will be carried out under such conditions of accommodation and equipment as can be obtained from the College resources.

The Board have, however, offered a grant of £500 per annum (conditional on £500 per annum being raised locally) towards the expense of establishing and maintaining a Plantation for Research work in Fruit and Hop-growing, the need for which has for some time been put forward by the College, and steps are now being taken to establish this project. Some of the points at which research work is needed in Fruit and Hop-growing were mentioned in the last number of the *Journal*—points of fundamental importance on which definite information is required. But the acquisition of this knowledge will take time, and " results " cannot be expected at once. Those who are unacquainted with the nature of true scientific research are apt to consider such work as valueless unless it can produce results " whilst you wait," and the danger of carrying on such an institution with grants from local authorities who cannot be expected to have a knowledge of or even to be in sympathy with scientific work, lies in the fact that the impatience of the rate at which " results " are published may cause the workers to justify their existence by the publication of hasty, unconfirmed results, from the fear that the financial aid will be withdrawn unless " monthly " bulletins are issued. There will be undoubtedly many minor but important problems which may be studied and possibly solved, but the main object of such a Research Plantation must be to work on fundamentals and to build up an edifice of scientific knowledge on foundations of the solidity and stability of which there can be no doubt.

———

A landmark in the history of Fruit-growing in Kent has been set up by the holding of the First Kent Commercial

Fruit Show at Ashford, at which all the Fruit shown was packed in the standard-size boxes. The organization of the Show was in the hands of the College, and for a first attempt the exhibition was a remarkable success, and demonstrated that for certain varieties of apples, the system of boxing was entirely suitable. It is intended to make this a yearly exhibition, and eventually, when our grading and packing has reached a sufficiently high standard, to hold the show in London and stand comparison with the displays of boxed fruit sent over by our Colonial and American competitors.

The congestion in the College buildings, owing to the considerable increase, not only in the number of in-college students, but in all branches of the external work, is now in definite prospect of being relieved, as a start has been made with the new quadrangle on the east side of the Gymnasium. This quadrangle (one half of which is being erected out of the College revenues, whilst for the remainder a grant is being sought from the Development Commissioners through the Board of Agriculture) will contain three common and reading rooms, twelve students' bed rooms and accommodation for two members of the staff, entomological laboratories (2), mycological laboratories (2), drawing office, horticultural and agricultural work rooms, lecture room and new administration offices for Principal, Secretary and Clerks, residential accommodation for the porter, and two sick rooms. A new dining hall is also contemplated, with more efficient kitchen accommodation.

The provision of these fresh teaching and research rooms will enable existing rooms to be used for an extension of the chemical and botanical departments, an agricultural lecture room, committee, visitors' and private rooms for members of the staff, whilst the refectory will probably be converted into a suitably fitted museum and reading room. The increased advisory work undertaken by the College, and the extension of this work to Sussex, for which the Board of Agriculture has made a grant of £1,000 per annum, renders imperative this increased accommodation, and when completed Wye College will challenge comparison with many of the best equipped Agricultural Colleges of the World.

There has been an active increase in the research departments of the College work as the reports in this number of the *Journal* will indicate, attention being mainly directed to Fruit and Hop-growing, and to certain parasitic infestations of sheep which have caused an immense amount of loss to flock masters in different parts of the country. As a rule, the farmer does not seek expert veterinary advice for his flock, but treats or prescribes for them himself, and in the event of death a rough postmortem may sometimes be made, and the cause of death attributed to "inflammation" without the cause of the symptoms of the inflammation being ascertained. It may be that the spread of an infection is thereby aided, as had the nature of the illness been definitely known, precautions by isolation of the animals, treatment of the ground or disposal of the carcases might be necessary in order to prevent further losses and the continuance of the trouble, but except in the cases of pedigree flocks the value of the animal appears hardly sufficient to warrant the calling in of professional attendance. It is only therefore by dissemination of the results of such investigations as are being carried on by the College with regard to sheep ailments that attention can be drawn to the matter, and there is no doubt that, with the increasing intensiveness of sheep farming in many districts, a more watchful eye must be kept on outbreaks of disease in order to secure the successful carrying on of the industry.

The tobacco-growing trials, which were instituted with the intention of providing a method for obtaining a cheap home-grown insecticide, have had rather a curious development; a report from one of the most experienced tobacco manufacturers is to hand, stating that one variety of the tobacco grown had qualities which would give it a good value for smoking purposes. In other districts, where these experimental crops of tobacco have been grown, a marketable quality has been secured, and many suggestions have been made that farmers should go in for growing the crop. It is probable, however, that the Excise regulations, which, owing to the importance of the tobacco duty amounting to some nineteen millions per annum, must neccessarily be exceedingly stringent, would form a serious obstacle to the general adoption of tobacco growing.

The following changes in the College staff have occurred :—

G. G. Macdonald, B.Sc. (Agric. Dept.), has been appointed Assistant Director Soudan Dept. of Agriculture, and is succeeded by C. Hutchinson.

S. J. K. Eames (Agric. Dept.), has been appointed Farm Manager, Rothamsted Experimental Station, and is succeeded by D. Davidson, A.R.C.S.

C. Hutchinson (Agric. Chem. Dept.), transferred to the Agricultural Department, is succeded by E. A. Fisher, B.A. (Oxon.)

T. R. Robinson (Agric. Dept.), has taken a farm in Surrey, and is succeeded by T. E. W. Dobson.

H. E. Hornby, M.R.C.V.S., has been appointed Assistant in the Veterinary Department.

R. C. B. Gardner has been appointed as Assistant in the Zoological Department, to investigate the life history, etc., of parasitic worms in sheep.

C. W. Jemmett has been appointed Assistant in the Zoological (Entomological) Department.

H. Wormald, A.R.C.S., has been appointed Assistant in the Botanical (Mycological) Department.

J. Williams has been appointed Assistant Farm Director and Practical Instructor, in part of his duties succeeding

J. Morison (Farm Superintendent), who has taken a farm in Kent.

The following are the occupations of past students, and appointments obtained during the past year.

S. J. K. Eames, Rothamsted Farm Manager.
C. W. Jemmett, Wye College, Entomologist.
R. Wellington, Wye College, Horticulturist.
W. B. Barling, Land Valuation Department.
R. Cox. Land Valuation Department.
F. W. Page-Roberts, Aspatria Agricultural College, Surveyor.
D. Eyre Baxter, Borneo Co., Mycologist.
G. Eyre Baxter, Borneo Co., Assistant.
G. Pearson, Borneo Co.
N. Butler, F.M.S., Rubber assistant.
J. H. Mattinson, B.Sc., Agricultural Expert, Permanent Nitrate Committee.

R. N. Dowling, Agricultural Expert, Sugar Beet Council.
T. H. Holland, Manager Tea Estate, Ceylon.
L. Hopkins, Manager Rubber Estate, F.M.S.
C. J. Alexander, International Agricultural Institute, Rome.
W. Hopkins, Director of Agriculture, Sierra Leone.
G. A. H. Bedford, Entomologist, South Africa.
R. S. Biscoe, Government Surveyor, Jamaica.
G. Fenoulhet, County Lecturer, Somerset.
R. F. Hankins, South African Agricultural Department.
V. S. Rawson, West Australia Agricultural Department.
L. F. Wacher, South African Agricultural Department.
H. G. Mundy, Botanist, Rhodesia.
H. L. Cable, Manager, Portuguese East Africa.
P. G. Kibler, Land Valuation Department.
O. Nares, Land Valuation Department.
E. R. Cave Browne, Manager Tea Plantation
R. Goodwin, South African Agricultural Department.

A considerable number of past students have settled on farms in England, many in the neighbouring counties.

The thanks of the College are due to many donors of books to the library and to the anonymous sender of No 12 of the *Journal*. The Librarian will be glad if those who have old copies of the *Journal*, specially Nos. 2, 3, 4, 5, 6, 7, 8, 11 and 12, would send them to him, as only one complete set is extant.

REPORTS

FROM THE

AGRICULTURAL

AND

DAIRYING DEPARTMENTS

THE FARM.

By J. Mackintosh.

In common with other counties in the midlands and south of England, Kent has suffered severely from the protracted drought of the past summer, but it is still possible to write of the year's work on the College farm in as satisfactory terms as last year.

Crops.

The winter of 1910-11 was extremely variable. October was a very warm month, and all the wheat sown then was put in with the soil warm and in excellent season; November was the wettest month of the whole year, with an average temperature, and this was followed by a dull and comparatively warm December. Of the spring months February was dry and bright and sowing was commenced on the 14th (three weeks earlier than last year), and continued under excellent conditions. After this good beginning the high rainfall and want of sunshine in March came as a hindrance, and the planting of the early potatoes was commenced at a later date and with the soil colder and wetter than usual. April was a good month, the main crop potatoes and roots being put in with everything in their favour. In May the dry period commenced, and continued until the end of September, with the exception of a night's rain at the end of May, and a few showery days in the third week of June. That some of the crops in this district are perhaps above the average for the year is entirely due to these few showers coming at a time when all crops could make full use of the moisture.

The grain crops were good on the whole, but some oats had to be sown a second time because of the ravages of wireworm. The harvest was finished in a remarkably short

time, all the crops being cut and stacked by the middle of August. The straw was short, but the yield and quality of the varieties of wheat, oats and barley which have been threshed are highly satisfactory.

The following list includes all the varieties grown and the yields per acre, and prices where the grain has been threshed and sold.

Wheat :—				
Red Standard	$4\frac{3}{4}$	qrs.	per acre	36s. to 38s. per qr.
Lord Chancellor	$4\frac{1}{4}$	,,	,,	37s. per qr.
Little Joss	$3\frac{5}{8}$	,,	,,	
Svalof Extra Square-head	$4\frac{7}{8}$	,,	,,	
Victor	6	,,	,,	36s. per qr.
Rough Chaff	5	,,	,,	36s. per qr.
Bon Fermier	$4\frac{5}{8}$	,,	,,	36s. per qr.
Oats :—				
Abundance	$7\frac{1}{4}$	,,	,,	24s. per qr.
White Cluster	$7\frac{1}{2}$	,,	,,	24s. per qr.
Beseler's Prolific	10	,,	,,	24s. per qr.
Bountiful	$6\frac{1}{2}$	,,	,,	
Black Tartar	9	,,	,,	
Barley :—				
Burton Malting	6	,,	,,	38s. to 40s. per qr.
Standwell	7	,,	,,	38s. to 42s. per qr.
Prize Prolific	7	,,	,,	40s. to 41s. per qr.
Peas :—				
Imperial Blue	$3\frac{7}{8}$	,,	,,	48s. per qr.

Several of these varieties are worthy of special mention; the "Little Joss" wheat is a variety brought out by the botanical department of Cambridge University, its parents are wheats of known excellence, "Rough Chaff" and "Ghirka,"—one of the best and strongest of Russian wheats—and although it did not crop well on the College farm last year, it has given heavy yields of high quality grain in other districts.

The " Svalof Extra Squarehead " is a variety from the noted Svalof Seed Selection station in Sweden, and has given good returns when tried in the North of England. The " Beseler's Prolific " variety of Oats was introduced into Scotland in recent years by the West of Scotland Agricultural College, and it is now widely grown ; its first trial at Wye has been distinctly successful.

The " Standwell " and " Prize Prolific " varieties of barley were notable for the excellence of the grain and the good yields per acre.

The potato crop was a marked contrast in several respects to that of last year. Spraying as a preventive of " blight " was the saving of last year's crop—the yields from sprayed and unsprayed plots showing a balance of four tons per acre in favour of the former—while this season " blight " was almost entirely absent, and the haulm at Michaelmas had the strength and greenness one usually associates with August. The yield has been highly satisfactory, rising to twelve tons ware and seed for some of the late varieties, but the late rains have prolonged, and in most cases, restarted growth, so that digging the crop has been a long drawn-out process. Prices have been, on the average, above those of last year, as, though a smaller figure was obtained from the first earlies, the late varieties have in only a few cases fallen as low as 80s. per ton, while 65s. per ton was the September price last season.

Varieties grown :—

First Earlies.

Epicure (Homegrown and Scotch).
Sharpe's Express (Homegrown and Scotch).
Royal Standard (Homegrown).

Second Earlies.

Eclipse (Homegrown and Scotch).
Edina (Homegrown)
British Queen (Homegrown and Scotch).
Colleen (Scotch).
New Success.
Macpherson (Scotch).
King Edward (Scotch and Lincs.).

Maincrops.

President (Homegrown and Kent).
Cora (Scotch).
Chancellor (Scotch).
Mayfield Blossom (Scotch and Homegrown).
Dalhousie (Scotch and Homegrown).
Triumph (Scotch).

Almost all the above varieties were quite successful, the exceptions being "Colleen" and "President," the latter variety has now been tried for three years, and has never given satisfaction; it is a most irregular grower and this defect more than counterbalances its blight-resisting properties. Of the varieties grown for the first time on the College farm, "Cora" proved of special excellence both as regards quality and cropping power, the yield being over thirteen tons per acre. The earlies were good for the season, the "Royal Standard" being the best; the second earlies were below the average for the College farm, as they suffered most from the drought which came just when they should have been making most growth; it is interesting to note that last season the "British Queen," home seed once grown, gave a larger crop than seed direct from Scotland. The maincrops were all very good, giving an average of ten tons of ware per acre.

Of the root crops mangels may be considered satisfactory, but swedes have been a partial failure. A small acreage of yellow turnips sown in June made poor growth till September when the rains brought about a great improvement; the same is true as regards the catch-crops.

Varieties grown:—

Mangels.	*Swedes.*	*Cabbage.*
Yellow Globe.	Champion.	Drumhead.

At the request of the Board of Agriculture five acres of the mangel ground were devoted to sugar beet; this crop was sown early in May, and did very well. The experiment was designed by the Board of Agriculture, and plots were laid out to test:—

(*a*) Sowing on the flat and on the ridge.
(*b*) Sowing on the flat with rows different distances apart.
(*c*) Sowing large, medium and small quantities of seed per row.
(*d*) Trial of varieties.
(*e*) Trial of different mixtures of artificial manures.

Full details of the methods and results of the experiment will be found on page 28.

The hay crop was the least satisfactory of all the farm crops; the seeds hay was cut and secured in good order, but no second cut was obtained as hay—a large portion having to be cut as green food for the cows. The meadow hay was a light crop of very good quality. Prospects for next year's seeds hay are by no means bright, as the dry summer has resulted in a very poor plant, and trifolium has been largely sown to make bulk for the first cutting.

The pasture fields suffered severely from the drought, but with an open autumn good growth was made, which postponed the use of the roots and hay.

Stock.—Prices for fat cattle have been lower than last year, the steers fattened during the winter and summer were sold at from £18 10s. to £23 3s. each, and those sold by weight made 13s. per score in December down to 11s. 9d. per score in July.

The dairy herd has suffered through the scarcity of grass, and the average yield per cow has fallen considerably. It was not possible to sell as much milk as usual during the summer, and the contract has not been continued for the winter; the surplus milk will be used for butter-making. The heifers for dairy purposes are a very good lot and should do well; a proportion will be available for sale during the next year.

Milk Yields :—

1909-10.	Average for 8 cows	— 7,930 galls.
	,, ,, 12 heifers	—6,196 galls.
1910-11.	,, ,, 17 cows	— 6,650 galls.
	,, ,, 2 heifers	—4,530 galls.

The full report of the dairy herd with the individual records of all the cows will be found on page 25.

The sheep stock did very well last winter, and also during the summer, but in April and May the Southdown ewes and lambs suffered from an attack of parasitic stomach worms and tapeworms. The death-rate from the stomach worms (*Strongylus contortus*, *Strongylus cervicornis*, etc.) has been increasing during the past three years, and as a result of serious losses and complaints from over a wide area special investigators have been appointed to study all phases of the subject with a view to providing both veterinary surgeons and farmers with accurate knowledge as to mode of infection, prevention and treatment

Last year a number of Southdown ram lambs were sold in the autumn for crossing purposes, and the results were so encouraging that this season a large number were prepared for sale for the same object.

These were sold at Ashford on October 10th and 21st, at prices ranging from 45s. to 6 guineas each ; the average for twenty-four was just under 3 guineas.

Sheep prices were :—

Southdown shearling rams, 85s. to 10 guineas ; Southdown ram lambs, 45s. to 6 guineas ; Southdown and Southdown Cross tegs, 25s. 6d. ; Southdown lambs, 10s. to 12s. 6d. ; Kent aged rams, 40s. and 45s ; Southdown and Kent ewes, 40s. 6d., 38s., 27s., and 20s. ; Southdown and Kent wethers, 54s., 44s., 36s. 6d. ; Hampshire Down ram lambs, 2 guineas ; Dorset Horn cross lambs, 37s. and 62s.

Two Southdown shearling rams were bought at 10 guineas and 14 guineas, and one Kent ram at 10 guineas.

Wool prices were as follows, last year's prices being given in brackets :—

Southdown ewe wool, 1s. $1\frac{1}{2}$d. lb. (1s. 2d. lb.) ; teg wool, 1s. $1\frac{1}{2}$d. lb. (1s. $2\frac{1}{4}$d. lb.) ; top prices of sales each year. Kent ewe wool, $10\frac{3}{4}$d. lb. ($11\frac{1}{4}$d. lb.) ; Suffolk, Hampshire and Dorset ewe wool, 1s. lb. ; teg wool, 11d. lb. ($11\frac{3}{4}$d. lb.) ; lamb wool, $7\frac{1}{4}$d. lb. ($9\frac{3}{4}$d. lb.).

The Southdown wool was sold by auction at Guildford, and the Kent Wool at Ashford.

Pork, like beef, has fallen in value during the year, and a smaller stock than usual is being carried through the winter. One hundred and twenty-two pigs of various ages have been

sold, at prices from 42s. to 82s. for porkers, £5, £6 and £6 10s. for fat pigs, and £5, £6, and £6 10s. for fat sows.

One Large Black gilt and a Middle White boar were bought for 5½ guineas and 6 guineas respectively.

Summary of pure breeds of stock on the farm :—

Cattle.	*Sheep.*	*Horses.*
Shorthorn.	Southdown.	Shire.
Lincoln Red.	Kent.	Clydesdale.
Sussex.	Dorset Horn.	Suffolk.
Aberdeen Angus.	Suffolk.	
Galloway.	Hampshire.	*Pigs.*
Ayrshire.	Lincoln.	Middle White.
Jersey.		Large White.
		Berkshire.
		Large Black.

In addition to growing the large number of varieties of grain, potatoes and sugar beet—some solely for demonstration purposes—the farm and crops were utilized for manurial trials with new nitrogenous manures, trials of various methods of eradication or checking of "tor" grass, potato spraying, growth and cultivation of tobacco, and a small area for demonstration plots of wheat, oats, barley, peas and tares.

Further information on the variation in the yield and composition of cow's milk has been collected, while trials were conducted with two new concentrated foods—coconut cake and para-rubber seed cake, both of which were apparently quite promising foods.

The produce from the College farm won the following prizes during the year :—

Tonbridge Show	..	First Prize for Wheat.
		First Prize for White Oats.
		First Prize for Black Oats.
		First Prize for Potatoes.
Ashford Show	..	First Prize for Crossbred Lambs.
		Second Prize for Fat Pig.
		First Prize for Oats.
		Second Prize for Potatoes.
East Kent Show	..	First Prize for Southdown Teg Wool.

During the past year a valuable addition has been made to the educational equipment of the agricultural department in the shape of a large shed stocked with many of the latest and best types of farm implements and machines. Most of the exhibits have been loaned by the various firms. The following list of manufacturers and implements will show the comprehensiveness and quality of this new addition to the practical side of the agricultural training available at the College.

Plough, with Ridging, Potato Raising and Subsoil bodies	Ransomes, Sims & Jefferies.
Plough	Cottis.
Harrows	Ransomes, Sims & Jefferies.
Harrows	Lott & Walne.
Cultivator	Ransomes, Sims & Jefferies.
Spring-time Harrow	International Harvester Co.
Cultivator and Seeder ..	International Harvester Co.
Corn Drill	Reeves.
Horse Hoes	Reeves.
Horse Hoes	Cottis.
Grass Harrow	Cottis.
Binder	Massey Harris Co.
Binder (Parts)	Harrison & Macgregor.
Mowers	International Harvester Co.
Mowers	Samuelson.
Rotary Corn Screen	Penney & Co.
Lamb Creep	Lott & Walne.
Incubator	Tamlin.
Egg Boxes	Tamlin.
Egg Boxes	Dairy Supply Co.

Goods are expected shortly from the following firms :— Brown & Son ; Standen & Co., Ltd. (Cultivator) ; Malden Ironworks Co. (Hay Sweep) ; Randall, Ltd. ; Walter A. Wood ; Edlington & Co., Ltd. (Potato Sorter) ; R. A. Lister (Grass Harrow, Horse Hoe, Separator).

It will be possible even after all the above are in position to afford floor space for several more, and every effort will be made to have the stock as complete and representative as possible of the various classes of farm machines.

Probably no subject included in the curriculum of an Agricultural College is so difficult for both lecturer and student as agricultural engineering and implements, if the practical work does not go hand in hand with the theoretical—and it will now be possible at Wye to make the course of instruction much more satisfactory and complete than was the case when only those implements and machines required for definite field and barn work were available. Through the kind co-operation of the various firms it will be possible to keep the stock thoroughly up-to-date; it would be a valuable addition to the College if an implement museum could be established, but the present demands on space forbid that this should be more than mentioned.

It is a matter for regret from every point of view that the buildings of the College farm cannot be written about in as satisfactory and optimistic terms as in the case of the implement shed.

The new cow-house and the alterations made in 1910 only make the poor condition of some of the other buildings more noticeable, and the increased production of the College farm and consequent ability to maintain more stock make the need for more box accommodation at Coldharbour Farm most obvious. The granary, food store, and barn accommodation is also very inadequate, both as regards space and protection from the weather. While it is undoubtedly a good thing that agricultural students should gain experience in adapting themselves to indifferent conditions, and in making the best of the circumstances in which they or their stock may find themselves, it is also true that this may be carried too far, and want of example (and precept without example is often useless) in improvement of old buildings and economical working arrangements of the various parts may result in much labour, time and money being spent in obtaining only second or third rate results in after years.

THE DAIRY HERD.

By J. Mackintosh.

The system of management inaugurated three years ago with a view to illustrate in the most concrete and practical fashion the keeping of a dairy herd and the production of market milk has been continued throughout the past year, but with less satisfactory results than formerly in some respects.

The milk contract came to an end last Michaelmas and was not renewed for the winter owing to the diminished yield of milk, high price of food-stuffs, and the need for more milk to provide butter-making instruction to the students. It will be possible and advisable to arrange for another contract when the coast town season commences.

The system of milk records in practice at the farm was explained fully in the *Journals*, No. 18, pp. 63, 64, and No. 19, pp. 33, 34, and the only alteration which has been made in the method of work or of stating the results is the addition of a column stating the length of the dry period before calving.

In the tables given on pp. 25 and 26 the cows and heifers have been placed in separate groups; only two heifers completed a lactation period with the year.

The average yield per cow has fallen to the extent of 1,273 lbs., a distinctly large decrease, but this is largely accounted for by the exceptionally dry summer which soon affected the cow pastures and reduced the yield, also the green crops used as supplementary foods were lacking in sap and palatability. There was a notable falling-off in the yield of four cows, which were expected to do very much better; in two cases the diminished yield was attributable to injuries to the udder, but the others decreased in production in a manner only partially accounted for by the natural individual variation. Two cows—L. 22 and S. 11—show notable increases, and the

MILK RECORDS OF THE DAIRY HERD.

Season 1910-11.

COWS.

No. of Cow.	Weeks dry before Calving.	Weeks in Milk.	Actual Yield of Milk.	Average Daily Yield.	Average per cent. Fat in Milk.			Calculated Yield of Milk in lbs. of 3 per cent. Fat.	Number of Calves.
					Morn.	Even.	Average.		
Lincoln :			lbs.	lbs.					
No. 13	17	36	6266	24.8	3.09	3.96	3.46	7227	6
No. 21	7	33	5223	22.6	3.36	3.91	3.60	6267	3
No. 22	7	50	10358	29.5	3.04	3.82	3.37	11635	2
No. 26	10	36	6315	25.0	3.23	4.03	3.75	7514	2
No. 27	27	25	3198	18.2	2.50	3.78	3.11	3315	2
No. 28	4	39	5101	18.6	3.17	4.00	3.51	5968	2
No. 31	6	70	6636	13.5	3.69	4.48	3.99	8825	2
Shorthorn :									
No. 1	13	43	7498	24.9	3.33	4.11	3.65	9122	5
No. 3	23	61	11230	26.3	3.02	4.33	3.54	13249	4
No. 5	10	33	4489	19.4	2.86	4.35	3.48	5207	5
No. 8	8	46	8197	25.4	3.21	4.36	3.69	10078	3
No. 11	6	44	7574	24.5	3.04	4.01	3.48	8785	2
No. 12	8	27	4174	22.0	2.84	4.04	3.37	4688	2
No. 13	7	44	6677	21.6	3.24	3.84	3.49	7767	5
No. 14	12	47	8130	24.7	3.10	4.10	3.51	9512	5
No. 20	?	41	7497	26.1	2.74	3.98	3.28	8163	4
No. 24	?	54	5982	15.9	2.76	3.89	3.23	6440	2
No. 25	?	40	5297	18.9	3.11	4.07	3.48	6144	3
Average for year of above 18 Cows			6657						
Red Poll	9	38	3756	14.1	3.19	4.13	3.57	4469	2
Kerry		50	4911	14.0					2

HEIFERS.

No. of Heifer.	Weeks in Milk.	Actual Yield of Milk.	Average Daily Yield.	Average per cent. Fat in Milk.			Calculated Yield of Milk in lbs. of 3 per cent. Fat.	Number of Calves.
				Morn.	Even.	Average.		
		lbs.	lbs.					
Lincoln :—No. 30	50	5097	14.5	3.12	4.09	3.54	6014	1
No. 33	28	3964	20.3	2.98	3.92	3.36	44.39	1
Average for year of above 2 Heifers		4030						
Ayrshire	47	7328	22.2	3.24	4.41	3.72	9086	1
Blue grey	52	4741	13.0					1

future performance of L 22 will be watched with interest, as she is the most promising cow ever bred by or in the possession of the College.

A comparison of the yields of the above six cows is given below :—

No. of Cow.	1910.		1911.		Decrease.
	Yield.	Lactation Period	Yield.	Lactation Period.	
	lbs.	Weeks.	lbs.	Weeks.	lbs.
L. 13	7936	37	6266	36	1670
L. 26	8940	49	6315	36	2625 {lost one quarter
S. 5	8595	41	4489	33	4106 {lost two quarters
S. 12	7124	51	4174	27	2950
					Increase, lbs.
L. 22	7774	49	10358	50	2584
S. 11	6298	45	7574	44	1276

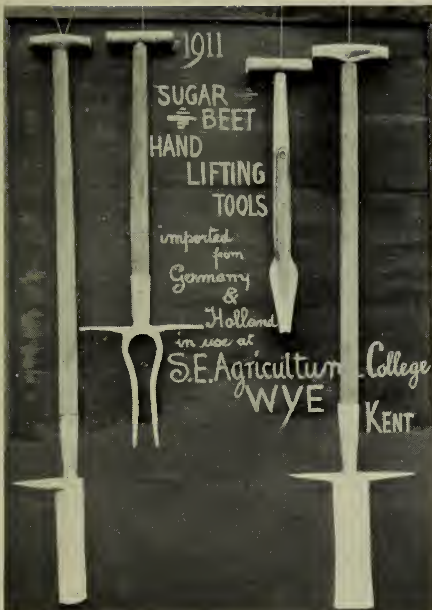
Attention might also be drawn to the records of two cows as illustrating the value of a milk record in showing not simply

the bad cows, but how bad the poor milkers are. Lincoln 27 and Shorthorn 12, after calving, gave $3\frac{1}{2}$ gallons and $4\frac{1}{2}$ gallons per day respectively, and both had large shapely udders, yet at the end of twenty-five and twenty-seven weeks both were dry. The low quality of the milk of L. 27 should also be noticed as an item of evidence against the often heard statement that poor milkers give rich milk.

Six cows average under the legal minimum of 3 per cent. butter fat in the mornings, but taking the average of both milkings all are above the "standard." The difference as regards butter fat between morning and evening milk is more than 1 per cent. in the case of ten cows, and the average difference is also practically 1 per cent., and this is in full agreement with the difference usually found where the intervals between the milkings approximate to fourteen-and-a-half hours and nine-and-a-half hours.

SUGAR BEET EXPERIMENTS.

Experiments on the growth of Sugar beet were first made at the College in 1900 and 1901 (see *Journal*, Nos. X. and XI.). The crop was again grown in 1905, and on both occasions satisfactory yields were obtained and the question whether a crop of high quality as regards sugar content could be grown on average land in an average season in England could have been regarded as answered in the affirmative. During the past two or three years, however, public attention has been again directed to the matter, and rumours of the erection of factories in many parts of England have been freely circulated, but no materialization has yet taken place, with the exception of a Norfolk factory, which is now being erected with the co-operation of the directors of certain Dutch sugar factories. In all other cases the difficulties have been commercial—the capitalist will not expend money—and some £120,000 to £150,000 is required—on the erection of a factory until he can get a guaranteed supply of the necessary quantity of raw material from the farmers in the neighbourhood, and the farmers will not grow the beet unless a guaranteed price is given for the crop. To definitely decide whether sugar-beet growing and sugar manufacture are industries which will succeed in this country, a trial on a commercial scale and with no artificial conditions must be made, and as this trial may prove a costly experiment, it has been argued that the State should guarantee the cost, but the expenditure of so large a sum on one industry might be open to grave objection at home and might be regarded by the governments of sugar-beet growing countries as a form of bounty on the industry—the Development Commissioners on account of these or other objections decided that such a project could not be undertaken out of the funds at their



MACHINE FOR LIFTING ROOTS.

Variety	Sugar in Beet.	Area of Plot. a.	r.	p.	Remarks and Manures.
	per cent.				
Kleinwanzleben Kleinwanzleben Elite Heine. Ri	12.93	0	3	6	
Fla	16.53	0	3	13	
Fla	19.24	0	3	15	
	18.39	0	3	18	
Original. (All $18\frac{1}{2}$-in. rows)	16.51	0	0	16	
	18.45	0	0	$9\frac{3}{4}$	
	18.86	0	0	$9\frac{3}{4}$	
VARIE					
Browne's	18.31	All $6\frac{1}{2}$p. (2 rows each)			
Willy Me	17.44				
Dippe Br	17.01				
Breustedt	14.31				
Aderstedt	15.17				
Aderstedt	15.78				
Strubesch	18.03				

Remarks and Manures:

All the land was manured in the Autumn with 16 tons of rather poor farmyard manure augmented with 4 cwt. of Fish Meal. The soil was fairly stiff loam with chalk subsoil.

In the Spring, before drilling, the following mixture was given:

100 lbs. Sulphate of Ammonia = 20 lbs. Nitrogen.
420 lbs. Super-phosphate 26% = 50 lbs. Phosphoric Acid (P_2O_5).
$62\frac{1}{2}$ lbs. Sulphate of Potash = 30 lbs. Potash.

and at time of singling:

67 lbs. Nitrate of Soda = 10 lbs. Nitrogen.

Sown between May 4th and 6th. (18 lbs. Seed per acre in all cases.)

Singled between June 8th and 12th.

Harvested from October 26th to November 16th.

ly has been

£	s.	d.
8	8	2
1	10	0
0	8	0
0	5	0
1	15	0
1	0	0
1	5	0
£14	11	2

Table I.

Results of Sugar Beet Experiments.

Per Acre.

Plot and Variety.	Roots Gross. Crowned and topped, unwashed. (tons cwt. qrs.)	Roots Net. Crowned and topped, washed. (tons cwts. qrs.)	Leaves and Crowns. Ensilage. (tons cwts. qrs.)	Tare. (per cent.)	Average weight per root, crowned, topped and washed. (lbs. ozs.)	Total solids apparent in Juice Brix. (per cent.)	Sugar in Juice. (per cent.)	Non-Sugar apparent in Juice. (per cent.)	Co-efficient of Purity. (per cent.)	Sugar in Beet. (per cent.)	Area of Plot. (a. r. p.)
Kleinwanzleben Kleinwanzleben Elite Heine. Ridges 22-in.	20 2 3	15 10 0	11 11 3	23	1 6	18.1	13.71	4.39	75.73	12.93	0 3 6
Flat, 22-in.	25 17 2	19 13 1	10 18 2	24	1 1	20.27	17.51	2.76	86.50	16.53	0 3 13
Flat, 18½-in.	20 0 1	15 12 1	9 3 3	22	1 2	22.40	20.38	2.02	90.99	19.24	0 3 15
,, 15-in.	22 2 0	16 2 3	7 6 2	27	12	22.40	19.47	2.93	86.94	18.39	0 3 18
Kleinwanzleben Original. (All 18½-in. rows) 20-lbs. Seed	23 7 2	18 14 0	8 10 2	20	1 2	20.40	17.50	2.90	85.76	16.51	0 0 16
15-lbs. Seed	25 18 2	20 4 2	9 5 1	22	1 0	22.60	19.54	3.06	86.50	18.45	0 0 9¾
10-lbs. Seed	26 8 0	20 1 1	8 11 1	24	15	22.95	19.97	2.98	87.04	18.86	0 0 9¾
VARIETIES.											
Browne's Kleinwanzleben "Elite" ..	23 13 1	17 19 3	8 2 2	24	15	22.20	19.40	2.80	87.38	18.31	All 6½p. (2 rows each)
Willy Mette's Kleinwanzleben "Ideal" ..	27 8 3	19 4 1	10 9 3	30	1 4	21.80	18.47	3.33	84.70	17.44	
Dippe Bros, W. I.	24 5 1	19 8 1	7 18 3	20	1 0	20.90	18.01	2.89	86.18	17.01	
Breustedt's "Elite"	27 7 2	21 12 2	7 19 3	21	1 3	18.60	15.16	3.44	81.51	14.31	
Aderstedter Original	28 5 1	19 10 0	8 8 2	31	1 2	19.50	16.07	3.43	82.39	15.17	
Aderstedter Original (hulled and disinfected)	28 16 1	20 15 0	8 19 4	28	15	20.40	16.71	3.69	81.93	15.78	
Strubesche Zuckerrubensamen	23 12 1	16 10 2	9 9 3	30	14	22.50	19.09	3.41	84.84	18.03	

Remarks and Manures.

All the land was manured in the Autumn with 16 tons of rather poor farmyard manure augmented with 4 cwt. of Fish Meal. The soil was fairly stiff loam with chalk subsoil.

In the Spring, before drilling, the following mixture was given:

100 lbs. Sulphate of Ammonia = 20 lbs. Nitrogen.
420 lbs. Super-phosphate 26% = 50 lbs. Phosphoric Acid (P_2O_5).
62½ lbs. Sulphate of Potash = 30 lbs. Potash.

and at time of singling:

67 lbs. Nitrate of Soda = 10 lbs. Nitrogen.

Sown between May 4th and 6th. (18 lbs. Seed per acre in all cases.)

Singled between June 8th and 12th.

Harvested from October 26th to November 16th.

Cost of Cultivation.—The following table shows the cost of cultivation. Net cost of horses and men only has been reckoned, and the residual value of manures used and value of tops and crowns has not been credited.

		£ s. d.
16 tons Farmyard Manure, value, carting and spreading		4 0 0
4 cwt. Fish Guano		1 15 6
Once Ploughing		0 9 0
Other manures, cost and sowing		1 12 6
Cultivations (two)		0 5 0
Harrowings (three)		0 1 6
1-horse rollings (three)		0 2 0
Drilling, 1 horse and 3 men		0 1 6
Light harrowing		0 0 6
Light rolling		0 0 8
Carried forward		8 8 2

	s. d.	£ s. d.
Brought forward		8 8 2
Hand side hoeing	7 6	
Singling	14 0	
Seconding and side hoeing	8 6	
		1 10 0
Horse hoeing (three times)		0 8 0
Four-horse machine lifter		0 5 0
Pulling, topping and crowning		1 15 0
Carting 20 tons, roots at 1s. per ton		1 0 0
Rent and Rates		1 5 0
		£14 11 2

disposal. The Board of Agriculture, however, were desirous of demonstrating the methods and costs of growing the crop on a sufficiently large area for commercial results, and granted the sum of £7 10s. per acre to the College for the growing of five acres, the Board supplying the seed and lending a lifting machine and laying down certain conditions as to seeding and manuring. Owing to the abnormal season, no conclusions can be drawn from the manurial trials—it is unnecessary, therefore, to publish the figures, but the following table will show the yields from the different varieties and different methods of seeding and cultivation.

Owing to the wet season during lifting, the tare or deduction necessary for dirt adhering to the roots is high. This would, of course, mean a corresponding deduction in price per ton if the roots were delivered at a factory, and unless this deduction is made plain at the start to the patrons or farmers supplying a factory, considerable disappointment and even ill-feeling may result. The weights of roots recorded speak for themselves, and the sugar content is as high and in some cases considerably higher than the average continental crop.

An illustration of the tool used for lifting—of German make—is given, and this implement did the work exceedingly well, but from the experience of continental beet-growers, hand lifting is preferable, and an illustration is also given of the hand-lifting tools employed.

It is unnecessary to go over the ground of sugar beet growing in this country again, especially as the experiences of the Cantley factory will probably answer the question as to whether the undertaking is likely to be commercially successful, but it would appear that in sugar beet growing and sugar manufacture a system of co-operation, so that the growers own the whole or a very considerable share of the factory, would promise the best chances of success.

The College were fortunate in securing the services of Mr. W. E. Sawyer, who had had much experience in Norfolk with the crop and with Dutch methods, to superintend the trials, and sincere acknowledgment must be made of his careful and energetic work in carrying the trials to a successful conclusion.

(See Table I).

FEEDING EXPERIMENTS WITH SUGAR BEET SLICES.

By J. Mackintosh.

In autumn 1911, arrangements were made with the National Sugar Beet Association, through their Agricultural Adviser, Mr. R. N. Dowling, for the carrying out of the following experiments. The Association supplied two kinds of slices or "Dried Pulp," stated to be of the following analysis :—

	Ordinary Slices.	*"Steffen" Sugar Slices.*
Crude Protein - -	8.1	6.3
Crude Fat - -	.5	.5
*Carbohydrates - -	64.4	68.6
Crude Fibre - -	18.7	10.5
Ash - - -	3.4	4.5
Moisture - -	6.9	9.6
	102·0	100·0
*Containing Sugar -	5·6	35·5

The "Steffen" slices are dried by a special process, and can be made with any percentage of sugar agreed on by the farmers and the factories, the price varying according to the percentage.

These slices, either in the wet pulpy form or in the dried state, constitute the by-product received by the farmer from the factory utilizing the sugar beet, and the main object of the experiments was to obtain information as to the effect and relative value of these by-products when fed according to ordinary English farm practice. The dried slices or pulp

were imported from Germany, and it is obvious that only the dried by-products can be tried in this country until there is a factory started in England to supply wet pulp.

It was decided that the ordinary slices containing the low percentage of sugar should be used in an experiment with fatting cattle, while the "Steffen" slices should be tried with milking cows.

Thanks are due to Mr. J. A. Symon, B.Sc., for his careful superintendence of the fatting cattle experiment during the Christmas vacation.

Experiment I.—With Fatting Cattle.

Plan of the Experiment.

As the food to be experimented with takes the place of roots in the daily ration, the plan of the experiment was that two groups of cattle should be selected, one group to get mangels, the other to get an equivalent amount of the dried slices, all the other foods—hay, chaff, cake, etc.—to be fed in equal quantities to both groups.

According to the starch equivalent method of food valuation, 1 lb. of the ordinary slices was calculated to be equivalent to 8 lbs. mangels, and these foods were fed in this proportion throughout the experiment.

The cattle used were a lot of ten Irish Shorthorn steers, bought on October 19th, 1911. They were weighed and tied up in the stalls on October 28th, and for the next three weeks all received the same ration of roots, fodder and cake:—

Cabbage and Swedes	45 lbs.
Hay	5 ,,
Soya Cake	3 ,,
Egyptian Cotton Cake	3 ,,
Oat Straw	*ad. lib.*

From Nov. 4th to 20th all the steers received 2 lbs. each of the Beet Pulp soaked in water and mixed with chaff, in order to accustom them to the food, and by the end of the preliminary period (Nov. 28th) all ate the pulp, although a few were somewhat slow in taking to it.

On Nov. 26th the steers were divided into two groups of five each of approximately equal weights, but this equality of numbers was upset in a few days by one of the steers in the Control or Mangel group developing a swelling at the brisket, which prevented him feeding out of the trough ; this steer was therefore removed from the experiment. It should also be mentioned that although the two groups were approximately equal as regards live weights the Group allotted to the Beet slices appeared to be slightly better " doers," and it was considerered advisable to have whatever unavoidable difference there might be in this respect credited to this group, in order that no failure which might follow the use of the new food should be attributable to the animals.

The experimental feeding was commenced on Nov. 20th, and the kinds and quantities of the various foods given are stated in Tables I. and II. on pp. 33 and 34.

Method of Feeding.

The mangels were fingered, mixed with hay and straw chaff, and fed three times a day ; the long hay was fed at mid-day, and the long straw morning and evening: the cake morning and evening. The beet slices were soaked in water for 1 to 2 hours, then mixed with the mangels and chaff, or with the chaff only when no mangels were given, and fed three times a day.

The amount of water absorbed by the dried slices was approximately four times their own weight ; 40 lbs. of slices absorbed 160 lbs. water, and when more water was added a little trickle of moisture drained away from the heap.

All the animals had the offer of water once each day, and those receiving the slices consumed more than those in the mangel group, *e.g.*, average per head per day taken by the Beet group, 5 gallons ; by the Mangel group, 3 gallons.

Notes on the Rations.

It was expected that it would be possible to increase the quantity of Beet slices more rapidly than the above table of rations shows, and also to do without hay, owing to the small supply available, but the increase of pulp by 2 lbs. per head per day on one occasion resulted in scouring of several of the

TABLE I.

CONTROL OR MANGEL GROUP.

Date.	Mangels.	Hay.	Hay and Straw Chaff.	Soya Cake.	Dec. Cotton Cake	Egypt. Cotton Cake.	Molascuit.	Treacle.	Straw.
Nov. 20th	56	8	6	4	—	4	—	—	ad. lib.
Dec. 2nd	64	4	6–8	4	—	4	—	—	do.
Dec. 16th	64	—	6–8	4	—	4	—	—	do.
Jan. 13th	64	4	6–8	4	—	4	1	—	do.
Jan. 20th	64	4	6–8	5	—	5	1	—	do.
Feb. 2nd	64	4	6–8	—	5	5	1	½	do.

TABLE II.

SUGAR BEET SLICES GROUP.

Date.	Mangels.	Beet Slices.	Hay.	Hay and Straw Chaff.	Soya Cake.	Dec. Cotton Cake.	Egypt. Cotton Cake.	Molascuit.	Treacle.	Straw.
Nov. 20th ..	40	2	8	6	4	—	4	—	—	ad. lib.
Dec. 2nd ..	40	3	4	6–8	4	—	4	—	—	do.
Dec. 9th ..	32	4	4	6–8	4	—	4	—	—	do.
Dec. 16th ..	24	5	—	6–8	4	—	4	—	—	do.
Jan. 1st ..	16	6	—	6–8	4	—	4	—	—	do.
Jan. 13th ..	8	7	4	6–8	4	—	4	1	—	do.
Jan. 20th ..	—	8	4	6–8	5	—	5	1	—	do.
Feb. 2nd ..	—	8	4	6–8	—	5	5	1	½	do.
Feb. 19th ..	8	7	4	6–8	—	5	5	1	½	do.

steers, so the slower rate of increase had to be resumed. In January it was necessary to use barley straw instead of oat straw for chaff, and this change made the mixture so much less appetising that molascuit, and later on treacle, had to be added to ensure satisfactory feeding. The slices mixture in this instance was apparently no more appetising than the mangel mixture, and both lots of bullocks cleaned up their food much better when the molascuit and treacle were added. A small allowance of long hay was again introduced at this time. In February decorticated cotton cake was given in place of soya cake to both groups.

Results (see Tables III. and IV. on pp. 36 and 37).

In studying these figures the most obvious point is the comparatively small daily increase in live weight, especially in the control group; in this connection it is interesting to know that during the preliminary period of three weeks' stall feeding the increase in live weight was very high, averaging 2·6 lbs. and 2·7 lbs. per head per day in the animals afterwards composing the two groups.

The supposition that the animals in the Beet group would prove better "doers" than the others was borne out by the results, in fact, while the first animal sold was No. IX. of the Mangel group (the best steer of the ten), the next four were all pulp fed. The fifth bullock of the Pulp group was a large, coarse-boned animal which matured slowly, though showing a live weight gain per day slightly above the average. The difference in the live weight increase per day in favour of the pulp fed group shows that the food is quite satisfactory, but the slightly superior quality of the animals in this group must be kept in mind. All the animals killed well, giving meat of excellent quality, and the percentage of carcase is well up to the average for this class of bullock—the slight difference in carcase percentage in favour of the control group is so small as to be negligible.

Conclusions.

1. That Dried Sugar Beet Slices when soaked in water and mixed with chaff form a sound and useful food for fatting cattle.

Table III.

Control Group of Four Steers.

No.	Weight when experiment commenced.			Weight when sold.			Increase in lbs.	No. of Days.	Increase per day. lbs.	Carcase Weight %.
	c.	q.	lbs.	c.	q.	lbs.				
I.	10	1	20	11	3	0	148	149	1.00	61.3
II.	9	3	16	11	0	0	124	127	.97	58.6
VII.	10	2	8	11	2	10	114	142	.80	61.8
IX.	10	2	24	12	0	21	165	100	1.65	58.9
Average	10	1	17	11	2	15	$137\frac{3}{4}$	$129\frac{1}{2}$	1.10	60.15

Table IV.

Sugar Beet Slices Group of Five Steers.

No.	Weight when experiment commenced.			Weight when sold.			Increase in lbs.	No. of Days.	Increase per day. lbs.	Carcase Weight %.
	c.	q.	lbs.	c.	q.	lbs.				
IV. ..	10	1	22	11	2	23	141	106	1.33	59.5
V. ..	10	0	16	11	2	10	162	113	1.43	59.6
VI.	9	2	22	10	2	16	106	113	.93	58.6
VIII.	10	2	24	12	2	22	222	163	1.36	58.4
X. ..	10	0	2	11	1	14	152	106	1.43	62.6
Average	10	0	23	11	2	11	$156\frac{3}{5}$	$120\frac{1}{5}$	1.30	59.74

2. That when mixed with chaff of inferior quality and flavour the addition of a small amount of sugar food or treacle improves the palatability of the mixture so that the animals clean it up readily.

3. That with animals tied up in stalls it was not found advisable to give more than 7 lbs. pulp per day, the animals eating 7 lbs. slices and 8 lbs. mangels plus chaff, more readily than 8 lbs. slices plus chaff without the mangels.

4. That 1 lb. pulp fed as above may be looked on as the equivalent of 8 lbs mangels.

Experiment II. With Milking Cows.

Plan of the Experiment.

Owing to the great individual variation in the yield and quality of the milk given by cows, it was not considered advisable to have two groups of animals, as in the case of the steers, but rather to restrict the experiment to two feeding periods with one group—a first period of five weeks on a mangel ration, and a second period of five weeks on a slices ration.

The cows were Shorthorns and Lincoln Reds which calved in January and February; the milk was weighed daily and samples taken morning and evening, and the percentage of butter-fat determined once a week. The cows were weighed at the beginning and end of each period.

The "Steffen" Sugar Slices used for this experiment were calculated to have a starch equivalent of 70, and as that of mangels is 7, the Slices were fed in the proportion of 1-lb. to 10-lbs. of mangels.

The Rations and Method of Feeding.

The following ration was fed during the first or Mangel period—March 3rd, to April 6th.

Bulky Mixture.

*60-lbs. Mangels. 15-lbs. Hay and Straw Chaff. $1\frac{1}{2}$-lbs. Dried Grains $1\frac{1}{2}$-lbs. Molascuit. $\frac{1}{2}$-lbs. Treacle.	All mixed together and fed to all cows four times a day.

2 to 3-lbs. Hay (long)

* At times Sugar Beets were mixed with the mangels—one part Beet to two of Mangels.

Concentrated Foods.

12-lbs. Special Mixture to two cows (S. 32, 33).
7 ,, ,, ,, ,, ,, (L. 36, 40).

The above Special Mixture consisted of $4\frac{1}{2}$ parts Dried Grains, 2 parts Decorticated Cotton Cake, 2 parts Bran, 2 parts Molascuit with 1 part each Linseed Cake, Egyptian Cotton Cake and Crushed Oats, and was usually fed in proportion to milk yield, but remained unchanged during the experiment.

After April 6th a quantity of the Slices were soaked in water and offered to all the cows in the cowhouse; all ate them at once with the exception of two, and these two seemed to have acquired the taste for them by the next day, when all the twenty cows readily ate up the quantity offered to them.

The four cows selected for the experiment were then given 4-lbs. each per day, and their allowance of mangels reduced to 20-lbs. each; the quantity of slices was increased by 2-lbs. at a time until by the 28th April 10-lbs. per head per day were given; this amount contained more nutritive matter than the 60-lbs. of mangels fed in the first period, but the increased quantity was given with a view to finding out if scouring, or any undue looseness would follow the use of as much as 10-lbs. per head per day. In no case did this occur, and throughout the period the cows were in excellent health and cleaned out their troughs in a most satisfactory manner.

The slices were soaked in water, absorbing twice their own weight, and were mixed with the chaff, etc., next morning.

The cows were tied up in the cowhouse all night, and turned into a covered yard for exercise and water daily from 10 a.m. to 3 p.m.

RESULTS.

Mangel Period—Five weeks. March 3rd to April 12th. Yield and Quality of Milk from each cow (see Table V., p. 40).

Slices Period—Five weeks, April 7th to May 17th. Yield and Quality of Milk from each cow (see Table VI., p. 41).

QUANTITY OF MILK.

The figures show a gradual decrease in the yield of milk from all the cows during the first five weeks, and, except in

Mangels Period.—Table V.

Date.	S 32.				S 33.				L 36.				L 40.			
	Fat percentage.			Total Milk.	Fat Percentage.			Total Milk.	Fat Percentage.			Total Milk.	Fat Percentage.			Total Milk.
	Morn.	Even.	Aver.		Morn.	Even.	Aver.		Morn.	Even.	Aver.		Morn.	Even.	Aver.	
				lbs.				lbs.				lbs.				lbs.
March 9	2·7	3·8	3·08	258	3·1	4·1	3·50	276	3·4	3·8	3·57	139	2·6	3·7	3·23	168
,, 16	3·4	3·9	3·60	252	2·8	3·7	3·15	282	3·8	3·9	3·85	142	2·3	3·7	2·88	155
,, 23	2·9	4·0	3·35	240	2·4	4·2	3·21	250	3·2	3·7	3·33	136	2·6	3·9	3·15	143
,, 30	3·0	4·1	3·47	235	2·7	4·0	3·23	263	3·3	3·6	3·41	127	2·7	4·0	3·25	136
April 6	2·9	4·0	3·33	235	2·65	3·9	3·14	250	3·3	3·9	3·55	130	2·75	3·8	3·18	137
Average			3·36	244			3·25	264			3·55	135			3·08	148
Average per day				34·85				37·74				19·25				21·11

Average per day for the four cows: Milk, 28·24-lbs.; Butter-fat, 3·30 per cent.

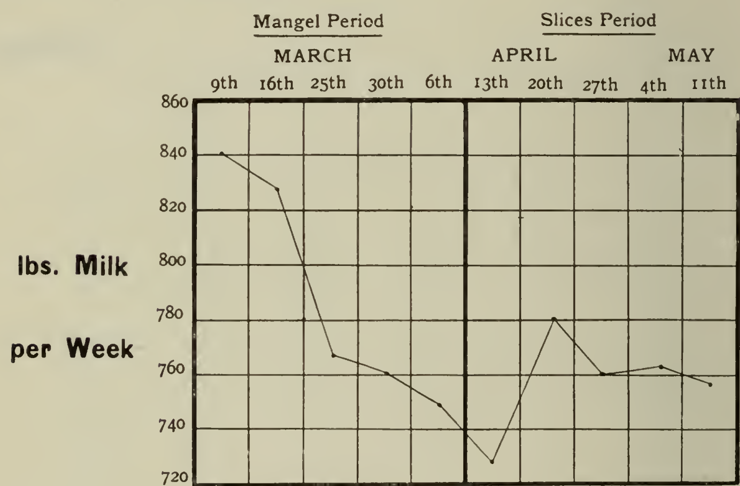
Slices Period.—Table VI.

Date.	S 32.				S 33				L 36.				L 40.			
	Fat Percentage.			Total Milk.	Fat Percentage.			Total Milk.	Fat Percentage.			Total Milk.	Fat Percentage.			Total Milk.
	Morn.	Even.	Aver.		Morn.	Even.	Aver.		Morn.	Even.	Aver.		Morn.	Even.	Aver.	
				lbs.				lbs.				lbs.				lbs.
April 13	2·7	4·1	3·30	230	2·5	4·0	3·21	232	3·4	3·7	3·51	136	3·2	4·2	3·59	132
„ 20	3·0	4·4	3·59	252	2·7	4·25	3·46	243	3·1	3·9	3·45	149	2·6	3·75	3·06	138
„ 27	2·9	4·2	3·44	246	3·15	4·3	3·63	226	3·2	4·1	3·61	142	2·4	3·6	2·89	146
May 4	2·4	3·9	3·00	241	2·4	4·0	3·10	238	3·5	4·4	3·88	136	3·9	3·8	3·85	150
„ 11	2·9	3·6	3·11	234	2·0	3·9	2·85	240	2·9	4·6	3·59	136	3·0	3·7	3·31	147
Average			3·30	240			3·25	236			3·60	139			3·34	142
Average per day				34·37				33·68				19·97				20·33

Average per day for the four cows: Milk 27·10-lbs; Butter-fat 3·35 per cent.

the case of S. 33, an increase during the second five weeks. It is most likely that had there been no change in the feeding the tendency to decrease noticeable in the first period would have continued during the second, and, therefore, the increase noted must be attributed to the food.

The following curve shows the gradual fall and subsequent rise due to the change of food.



The second period of the experiment coincided with the growth of grass in the fields, but the cows of the group kept indoors and getting no green food showed as large increases as those going out daily and having the advantage of the spring grass.

The decline in the average yield per cow per day from period I. to period II is. very slight—from 28.24-lbs. per day to 27.10-lbs.—and is less than would be expected over two five week periods with cows twelve to sixteen weeks after calving.

Quality of Milk.

As regards quality the figures show a decrease in the case of S. 32 of .06 per cent., and increases of .05 per cent. and .26 per cent. in L. 36 and L. 40 respectively, while the average of S. 33 is the same for each period. The average increase over

the whole group is only .05 per cent. and this is too slight to enable one to draw conclusions of any kind.

Flavour of Milk and Butter.

The milk showed no uncommon flavour of any kind while the slices were being fed, and the butter made from the cream after separating was exactly comparable with that made during the mangel period, *i.e.* typical of the pale-coloured, somewhat hard butter obtained when cows are fed entirely indoors.

Live Weight of Cows.

Table VII.

	S 32.	Inc. or Dec.	S 33.	Inc. or Dec.	L 36.	Inc. or Dec.	L 40.	Inc. or Dec.
	c. q. lbs.		c. q. lbs.		c. q. lbs.		c. q. lbs.	
March	11 0 25		10 1 20		8 2 23		9 0 0	
April	10 3 4	—49	10 0 26	—22	8 2 14	—9	8 0 21	—89
May	9 3 20	—96	10 0 0	—26	8 1 0	—42	8 2 22	+57

The above figures show an all-round decrease during the ten weeks of the experiment, with the exception of L. 40. This loss was most pronounced during the Slices period, in the case of the two cows S. 32 and L. 36, while with L. 40 the same feeding gave an increase. The complete ration fed during both periods could not be called a light one by any means, and an increase in weight might reasonably have been expected, but in this connection one must keep in mind the great variation in the live weight of cattle which will occur under the same conditions from day to day—out of twenty-six cows weighed by the writer at the same time on three successive days, nineteen showed variations from 12 to 40-lbs.

Other Effects.

The experiment extended over too short a time to enable one to come to any conclusions regarding the effects of the food on the breeding powers of the cows, but this point should be kept in mind in considering the general utility of sugar foods. In the above case S. 32 was served on April 30th, but none of the others have as yet (June 1st) come in season.

Conclusions.

(1) That the "Steffen" Sugar Slices when soaked in water and mixed with chaff, etc., form an appetising food for milking cows—more appetising than chaff, etc., and mangels.

(2) That 8 to 10-lbs. per head per day may be given to cows of 9 to 11 cwt. without any notable laxative effect.

(3) That 10-lbs. per head per day had no effect in increasing or decreasing the percentage of butter-fat in the milk, or on the colour and flavour of the butter produced.

INVESTIGATION IN THE FEEDING OF COCONUT CAKE TO MILCH COWS.

Conducted at the South-Eastern Agricultural College, Wye, during the months of April and May, 1911.

By Sydney Skelton.

Feeding Coconut Cake to Dairy Cows.

This investigation was carried out on the College Farms during the months of April and May, 1911, its object being to determine the suitability or otherwise of Coconut Cake as a food for the production of milk and butter; factors of importance in the production being:—

(*a*) The quantity and the quality of the milk.

(*b*) The quality of the butter.

(*c*) The effect of large quantities of this food on the "Reichert Number" of the butter fat; whether such butter is liable to be suspected of adulteration.

Cows Selected.

Three Dairy Shorthorns were selected (numbers 8, 11 and 20) which had calved on January 24th, January 23rd and February 3rd respectively.

It would have been advisable to have included several other cows, but this was not possible as a contract had to be fulfilled, and more milk was not available.

Method of Procedure.

The experiment was divided into three periods:—

(1) A period of normal feeding from April 8th to April 21st.

(2) A period of Coconut Cake feeding from April 22nd to May 12th.

(3) A period of normal feeding, being a return to the conditions of the first period, from May 13th to May 20th.

During the whole of the experiment the cows were kept in covered yards.

FOOD AND QUANTITIES FED.

First and Third Periods.—The rations and the amounts fed to the three cows were rather different ; these differences were necessary, owing to the greater quantity of milk given by "Shorthorn 20," and to the fact that "Shorthorn 11" would not eat cotton-seed cake, nor "Shorthorn 8," soya cake.

Rations in lbs. :

	No. 8.	No. 11.	No. 20.
Undecorticated Cotton Seed Cake (Egyptian)	5	—	2
Soya Bean Cake	—	4	3
Maize Meal	2	2	2½
Bran	2	2	2½
Dried Grains..	2	2	2
Molascuit	2	2	2
Roots	60	60	60
Oat Straw			
Barley Chaff	10.12	10.12	10.12
Meadow Hay (little)			

The molascuit and dried grains were mixed with the fingered roots and chaffed hay and straw, this mixture was divided into four equal lots which were fed as follows :—

1st, 5.30 a.m. 3rd, 3.15 p.m.
2nd, 9 a.m. 4th, 5.30 p.m.

The cake and bran were fed separately.

The Coconut Cake Period.—April 22nd to May 12th.

The Coconut Cake was soaked for four or five hours before use in twice its weight of water; this was found advisable on account of its great absorbent power. The quantities of this cake given to each cow daily, in three equal lots, were :—

April 22nd	2 lbs. each.		April 27th	5 lbs. each.	
,, 23rd	3 ,,	,,	,, 28th	5 ,,	,,
,, 24th	3 ,,	,,	,, 29th	5 ,,	,,
,, 25th	4 ,,	,,	,, 30th	6 ,,	,,
,, 26th	4 ,,	,,		to May 10th.	

Diminishing quantities of the other cakes were given until Thursday evening the 27th April, and then discontinued. The bran was given until the 29th. The maximum amount (6-lbs.) of Coconut Cake was continued until May 10th and then reduced, until Friday morning, May 12th, after which date none was fed.

MILKING AND SAMPLING.

The cows were carefully milked twice daily, 6.15 a.m. and 4 p.m., and after the weighing, the milk of each cow was thoroughly mixed and sampled. Separation immediately followed, the cream being set aside to ripen.

Samples of the milk were taken morning and evening; the percentage of fat determined by the Gerber method, and the specific gravity by the Westphal Balance. From the figures thus obtained the percentage of solids not fat was derived.

RESULTS.

A. Effect on quantity of Milk (Average yield in lbs.).

(See Table p. 48).

It will be noted that there was a slight decrease in the quantity of milk yielded during the Coconut Cake period, which persisted after reverting to the original feeding conditions. The slight increase of .43-lbs. shown by Shorthorn 20 in the third period is so small as to be neglected.

The figures show, as one would expect, a normal decline in the yield, as the lactation period advances.

Table I.

Effect on Quantity of Milk.

	Time.	lbs.			Specific Gravity.		
		1st period.	Coconut period.	3rd period.	1st period.	Coconut period.	3rd period.
Shorthorn 8 ..	Morning ..	18.32	20.00	19.25	1.032	1.029	1.030
	Evening ..	14.35	11.35	11.50	1.030	1.030	1.029
	Mean ..	16.33	15.67	15.37	1.031	1.0295	1.0295
Shorthorn 11 ..	Morning ..	17.44	17.11	17.40	1.032	1.030	1.031
	Evening ..	12.65	12.02	11.12	1.031	1.030	1.031
	Mean ..	15.04	14.56	14.26	1.0315	1.030	1.031
Shorthorn 20 ..	Morning ..	20.41	19.38	20.57	1.031	1.030	1.032
	Evening ..	15.46	15.17	14.83	1.032	1.030	1.029
	Mean ..	17.93	17.27	17.70	1.0315	1.030	1.0305

B. Effect on quality of Milk (Average fat percentage in milk).

	Time.	1st period.	Coconut period.	3rd period.
Shorthorn 8 ..	Morning	2.37	2.92	2.75
	Evening	4.07	3.42	3.70
	Mean	3.22	3.17	3.22
Shorthorn 11 ..	Morning	2.64	2.91	2.73
	Evening	3.56	3.55	3.36
	Mean	3.10	3.23	3.04
Shorthorn 20 ..	Morning	2.50	2.55	2.46
	Evening	3.20	3.38	3.30
	Mean	2.83	2.96	2.88

The above figures are interesting from the fact that most workers find that new foods may raise or lower the fat yield for a few days, but that it usually falls or rises to normal after a short period.

It will be noted that, with the exception of Shorthorn 8, there was a small increase during the Coconut period of twenty-one days, and practically a return to the original percentages during the third period.

It would be necessary to repeat the above experiment or to have extended the periods before it would be safe to assert that Coconut Cake does increase the percentage of fat in milk, but the above results scarcely confirm those of Hansen, of the Royal Agricultural Academy, Germany, who found that Coconut Cake "increased to a marked extent the fat content of milk." Messrs. Goodwin and Mackintosh working with Coconut Oil found a very slight increase due to feeding the oil, but the increase was very small, and was probably the normal rise of advancing lactation period.

C. Solids Not Fat.

		1st period.	Coconut period.	3rd period.
Shorthorn 8 ..	Morning	8.66	8.20	8.40
	Evening	8.40	8.55	8.55
	Mean	8.53	8.37	8.47
Shorthorn 11 ..	Morning	8.82	8.47	8.55
	Evening	8.98	8.58	8.80
	Mean	8.90	8.52	8.69
Shorthorn 20 ..	Morning	8.51	8.42	8.56
	Evening	8.87	8.60	8.70
	Mean	8.67	8.51	8.63

The decrease in solids not fat during the Coconut period is small but marked, and exceeds what one would naturally expect from an increase in fat.

D. Effect on the Butter.

Preliminary Period.

During this period there were six churnings, and with the exception of one churning some cream separated from the milk of the whole herd was included. The butter obtained solely from the cream of the experimental cows was very similar, being rather paler in colour due to the absence of Jersey milk.

Details of Churning.

Churning temperature, 58° to 60° F.

Time until breaking twelve to twenty-four minutes.

Temperature at breaking 58° to 60° F. The temperature of the dairy was kept artificially raised in order to assist ripening.

Coconut Cake Period. (Six Churnings).

Churning temperature 58° to 60° F.

Time until breaking nine to eighteen minutes.

Temperature at breaking 58° degrees to 63° F. The weather was warmer during this period and the cream was allowed to ripen naturally.

The butter during this period was distinctly firmer, and somewhat paler in colour, but the flavour was quite satisfactory ; it also took a longer time to gather, that is, a longer time elapsed after the butter began to appear before it was ready for washing than during the other periods.

The advantage of food capable of making the butter firmer was especially brought out during the warmer weather of the second period, as butter made from cream of the other cows not receiving any Coconut Cake, was extremely difficult to work and make up, although the temperature of churning was several degrees lower. The butter also well retained its firmness on keeping.

THIRD PERIOD. (Four Churnings).

Churning temperature 58° to 61° F.

Time until breaking seven to twenty-three minutes.

Temperature at breaking 58° to 61° F. The butter was softer during this perod, but in good working condition. There was practically no perceptible change in colour, the characteristic pale colour of butter from cows on winter rations being maintained.

THE REICHERT-WOOLNY NUMBER.

	1st period.	Coconut period.	3rd period.
	29.50	30.19	29.15
	29.67	30.69	30.89
	29.60	30.60	30.69
	28.90	29.94	30.85
	31.04	29.81	—
	29.42	28.70	—
Mean	29.67	29.06	30.39

These determinations were carried out in the usual way, and an examination of the figures shows only a slight difference for the three periods.

It will be observed that the first period shows a lower average than the others ; this was due to the cream of the first period being mixed with that of the rest of the herd, as previously mentioned, for additional determinations made during the first period showed that the butter derived exclusively from the experimental cows gave higher numbers than that from the entire herd.

The following notes on the nature and composition of the food used in this experiment may be of interest.

Coconut or Cocoanut is the fruit of a palm known as *Cocos mucifera* and although a native of the Indian and Pacific Oceans is now cultivated throughout the tropics. The tree attains a height from sixty to one hundred feet and is usually a straight stem, terminated by a crown of feathery leaves. Five to ten years elapses before the palm becomes productive and it continues so for seventy to eighty years, producing nuts at the rate of one to three hundred per annum.

The nut itself consists of a fibrous pericarp, from which the fibre known as Coir is prepared, a hard shell and an edible kernel. The kernel in the young nut is in a fluid state (the milk), later it sets, forming an albuminous lining in the mature shell ; this on being removed and dried is called "Copra," and it is in this form that Coconut reaches the Cake Manufacturers in this country. A valuable oil is expressed from Copra and the residue forms the Coconut Cake or "Poonac" of Commerce.

Coconut Cake varies a good deal in composition, as the analyses in Table on p. 53 show, and with this, as indeed with most feeding stuffs, it would be advisable to demand an analysis.

Summary of Results.

(*a*) Quantity and quality of the milk. In the former a negative result was obtained, but there was a slight increase in quality due to the feeding of Coconut Cake.

(*b*) The butter obtained was of a satisfactory quality, and the use of the cake should prove very useful to butter-makers,

Composition of Coconut Cake.

	J. A. Voelckler	Henry.	Crowther.	The Author.
Albuminoids	20.38*	19.70*	22.00*	17.87*
Oil	10.98	11.00	10.00	9.91
Carbohydrates ..	42.43	38.70	36.00	33.55
Mineral Matter ..	6.03	5.90	—	5.69
Fibre†	12.21‡	14.40	15.00	20.55
Sand	—	—	—	0.63
Moisture	7.97	10.30	11.00	11.80

* Containing Nitrogen .. 3.26 3.00 3.52 2.86
† Mucilage, Sugar, Digestive Fibre, etc.
‡ Woody Fibre.

who, experience a difficulty in obtaining firm butter during the warm weather.

(*c*) The effect on the "Reichert Number" is so slight as to be of no practical importance.

Conclusions.

Coconut Cake is a thoroughly satisfactory food for Dairy Cows and may be safely fed in quantities up to five pounds per diem. Henry ("Feeds and Feeding") states that it has also been fed to horses, and that as a result of experiments conducted by the French War Department, was found equal to, or even superior to, the same weight of Oats in an ordinary ration, further that it may be used with advantage for pigs and sheep.

Kellner ("Scientific Feeding of Animals") says: "With foods tending to give a soft oily bacon, it is advisable to feed at same time some Palm nut or Coconut meal, either of which tends to correct the softness," and again, "butter is often too soft when the following have been fed, crushed oats and maize, wheat bran, rice meal, rape, sesame and sunflower cakes. The effect naturally depends upon the quantities which are

used, and is not always apparent, particularly when the influence of the other foods in the ration is in the opposite direction."

In any case, a butter which is too hard may be improved by feeding with some rape cake, rice meal or ground maize, whilst one that is too soft may be hardened by means of Palm nut or Coconut Cakes.

WORKS CONSULTED.

Henry's "Feeds and Feeding."
Kellner's "Scientific Feeding of Animals."
Journal of the South-Eastern Agricultural College, No. 17.
"Standard Cyclopædia of Agriculture."

POULTRY.

By T. R. Robinson, F.S.I.

The season has been fairly satisfactory as regards poultry breeding, but owing to the great heat and lack of natural food, the birds have not grown out so well as in other years.

Sussex, Orpingtons, Leghorns and Faverolles are the chief breeds maintained on the farm. Various crosses are made up with a view of showing different systems of management.

REPORTS

FROM THE

HOPS & HORTICULTURAL DEPARTMENTS.

FRUIT DEPARTMENT.

By C. S. Smith.

Probably this season has produced a record crop of fruit, particularly in the case of apples, which are not only a heavy crop, but of excellent quality and very free from scab. Late apples do not appear to be keeping well, presumably on account of the exceptionally hot weather during the growing period.

In the College plantation the Newton Wonder Apples suffered somewhat from lime-sulphur spray, but though on the small side the fruit is exceptionally high coloured.

Bramley's Seedling, Lane's Prince Albert and Worcester Pearmain, have all given fairly satisfactory crops.

The young trees in the plantation have done fairly well in spite of the drought, and the grafted trees have made exceptionally good growth. The weather has been very trying for the young trees from America; these consist of twelve varieties, all of which are advertised as late dessert apples. They are as follows:—(1) Winter Banana; (2) McIntosh Red; (3) Coos River Beauty; (4) Grime's Golden; (5) Delicious; (6) Hubbardston Nonsuch; (7) British Columbia; (8) York Imperial; (9) Orenco; (10) Golden Russet; (11) Winterstein; (12) Akin.

Three trees of each variety were planted, but several have succumbed, in spite of continual watering; it will not be possible to give any opinion as to the value of these apples for several years, but McIntosh Red and Winter Banana have started away better than the others. American Gooseberry Mildew is still present in the College plantation, and most of the old Gooseberry bushes will have to be destroyed this autumn.

THE PACKING OF APPLES IN NON-RETURNABLE WOODEN BOXES.

By C. S. Smith and R. Wellington, M.S.E.A.C.

The practice of boxing apples, while general in America and our colonies, has at present been tried in this country only on a limited scale. On this account the present article and especially the part dealing with the suitability of the different packs to the various varieties of apples grown in this country, must be taken as indicating the general lines to be followed.

Apples which are to be packed in boxes must be very carefully picked in order to reduce bruising to a minimum. The apples should be graded at picking, so that all small, deformed, bruised or blemished fruits are removed. In order as far as possible to avoid extra handling, the sound apples are best stored in boxes (see Plate I.) which should be made with large spaces for ventilation. A convenient size is 20-in. long by 14-in. wide and 10-in. deep. Apples which are to be boxed should not be stored in a heap, as bruising is then frequent, and an extra handling is necessary to place the apples on the packing table.

The boxes to be used for sending the graded apples to market must be non-returnable, and in order to standardize the package, those made to the following specifications should only be used :—

"Federation Standard" ..	20-in. long by 11-in. wide by 10-in. deep (inside measurement).
"Federation Special" ..	18-in. long by $11\frac{1}{2}$ in. wide by $10\frac{1}{2}$-in. deep (inside measure ment).

Heads to be in one piece	..	$\frac{3}{4}$-in. thick.
Sides to be in two pieces	..	$\frac{3}{8}$-in. thick.
Tops and bottoms in two pieces		$\frac{1}{4}$-in. thick.
Cleats, two for each top and bottom		$\frac{1}{4}$-in. thick by 1-in. wide by 11-in. long.

Cement-coated $1\frac{1}{2}$-inch nails are the best for putting together.

In making the box the sides are always nailed to the cross-grained edges of the heads. The top and bottom are nailed only to the ends of the box, using a cleat. The top and bottom should never be nailed to the sides, otherwise no bulge is obtained, and the apples will be badly bruised. (Some of the ends will be found either actually broken or with shakes so that they will be liable to split, these can be mended with skeleton clamps costing about 5s. 6d. per 1,000).

The two sizes given above are suitable for apples of any size and shape, when used in conjunction with the various packs described below.

A special packing table (see Plate II.) is needed, not only to facilitate the work, but also to ensure the display to the packer of a large number of apples, so that he can choose quickly those of the desired size and shape.

This table can easily be made at home. A convenient size is 3-ft. high by 5-ft. long by 3-ft. 6-in. wide. The top of the table can be made of ordinary match-boarding, with a hop pocket or some such material as sacking nailed over to prevent bruising. A bevelled rail about three inches above the top of the table must be put round the sides and ends to prevent the apples rolling off. Two packers can work at such a table, and two box-rests 22-in. long should be fixed to each side. These rests should be fixed obliquely to the side so as to tilt the box towards the packer. The top end of the rest should be level with the top of the table, and the lower end should be of such a height that when a box is placed on the rest, the packer when standing upright can just reach the lower corners with his fingers.

The two essentials of box-packing are *honesty of sample* and *uniformity of grade*. The first implies that a box must never be topped, that is to say that the quality and size of the apples in each layer must be the same. With regard to

the second point, if grading is uneven a tight and uniform pack is impossible.

The chief aims of the packer must be to pack in such a way that each apple will be quite securely fixed without being so tightly squeezed as to be bruised; also that all apples in the box be as nearly as possible the same size. In order to attain this latter point three to four bushels of apples should be on the packing table to allow the packer a good choice.

For good packing it is necessary to obtain, in the middle of the last layer packed, a crown or bulge about ½-in. to 1-in. above the sides of the box. When the box is nailed up this will cause the top and bottom to spring, giving a bulge of from ¼-in. to ½-in. to each (see Plate IV.).

To obtain this bulge, the slightly smaller apples are packed at the ends of the layer, while the larger ones are placed in the middle.

This bulge should not be greater than that previously stated, otherwise the apples will be bruised by the pressure. It is just as harmful, on the other hand, to have an insufficient bulge—the top and bottom will not then be sprung and, in consequence, the apples when they settle will not be kept tight, and, in transit to the market, will shake so as to bruise badly, besides destroying the attractiveness of the pack.

In order to make the package attractive a good face should be obtained to the side which is to be opened. This is ensured by packing the box so that the first layer packed is the top layer of the box when opened. That is to say the bottom of the box (when in position on the box-rest) becomes the top of the finished box.

Before the actual packing starts, a few preparations are necessary. A thin layer of wood-wool is placed on the bottom —not however, up the sides or ends. The sides are then lined with ordinary packing paper. Two sheets are required for each box—these should overlap at both top and bottom, and care should be taken that the paper is well pressed into the angles between the bottom and sides, otherwise the paper will split when the bottom bulges. The paper for "standard" boxes should be about 32-in. long by 20-in. wide, and for the "special" 32-in. by 18-in.

No lining paper need be placed against the heads, and no paper or wood-wool is placed between each layer of apples.

Having made these preparations the box is packed in one of the styles mentioned below. Bearing in mind that the box is to look attractive, the apples should be placed so as to bring out the best points.

Apples with a handsome eye such as Blenheim Orange or Cox's Orange Pippin should be placed eye downwards, so that the eye is exposed when the box is opened. Some apples, on the other hand, colour well chiefly on one cheek, for example, Worcester Pearmain. These can be packed so that the cheek is displayed when the box is opened. Tall apples, also, generally pack best on their sides. Other apples such as Prince Bismark are shaped so that they taper towards the eye. If packed eye downwards, the box, when opened, seems badly filled—such varieties pack best either on their side or stem downwards.

When the last layer has been finished, the paper is folded over, a layer of wood wool is placed on top, and what is really the bottom is nailed on with the aid of a press (see Plate III.).

The packed boxes should always be stood on their sides, otherwise the weight of the boxes above will be brought directly on the apples, and in consequence bruising will result.

To finish for sending to market the box is labelled or branded with the grower's name, the trade mark, the variety and the number of apples in the box. There is no necessity to state the nett weight, since boxed apples are invariably sold by count, and the weight varies with the variety and size.

The styles of packing chiefly used are:

(1) Diagonal—(See Figs. 1, 2, 3. Plates V., VI., VII.).

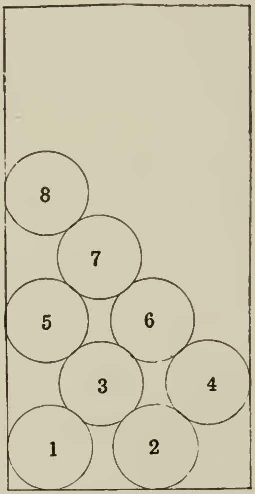
As the name implies, the rows run diagonally across the box. This style is most suited to general use. The fruit so packed travel better on account of the greater proportion touching each other, and the smaller proportion touching the box. It is also easier to obtain a good crown than with the straight method.

There are three "diagonal" packs.

(*a*) *Two-two pack*—(See Fig. 1 and Plate V.).—This is started by placing one apple in the lower left hand corner of

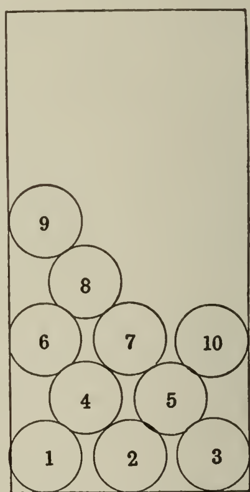
the box, and the next in the centre of the space between the first and the right hand side of the box. An equal space will then be left on each side of the second apple. Place two apples firmly in these spaces, and continue by making complete diagonal rows until the other end is reached. Two small spaces will then be left, and if the apples are pressed downwards towards the packer, these will be increased sufficiently to allow the last two apples to be placed in position. This layer should then be quite rigid so that if the box be tilted it will not fall out. Begin the second layer by placing the first two apples into the two little pockets

FIG. 1.



DIAGONAL TWO-TWO PACK.

FIG. 2.



DIAGONAL THREE-TWO PACK.

formed by the first four of the first layer, and continue as with that layer. Build up the third and fourth layers in the same way—always in the pockets formed by the layers underneath.

Each cross row will have only two apples in it, hence the name of the pack. This method can only be used with large apples.

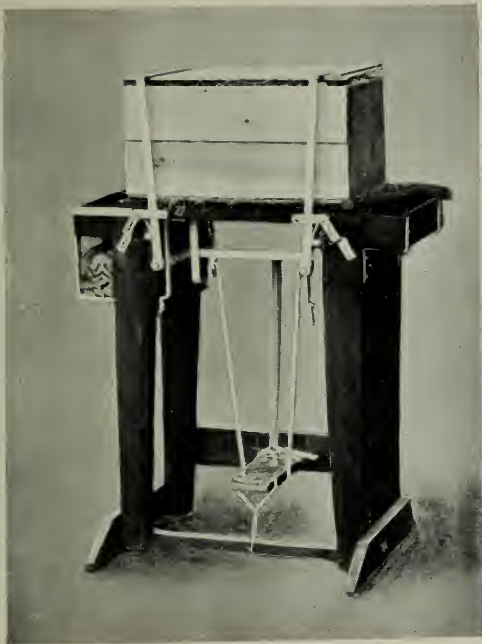
(*b*) *Three-two pack*—(See Fig. 2 and Plate VI.).—This is used for medium sized apples. Each cross row has alternately three and then two apples in it. Start by placing three apples across the end of the box; one in each corner and one in

[*W. E. Sawyer, photo.*

PLATE I.—STORING BOXES.

[*W. E. Sawyer, photo.*

PLATE II.—PACKING TABLE, SHOWING BOX-REST.



[*W. E. Sawyer, photo.*

PLATE III.—APPLE BOX PRESS.

[*W. E. Sawyer, photo.*

PLATE IV.—APPLE BOX, SHOWING BULGE ON EITHER SIDE.

[*W. E. Sawyer, photo.*

PLATE V.—DIAGONAL TWO-TWO PACK.

[W. E. Sawyer, photo.
PLATE VI.—DIAGONAL THREE-TWO PACK.

[W. E. Sawyer, photo.
PLATE VII.—DIAGONAL THREE-THREE PACK.

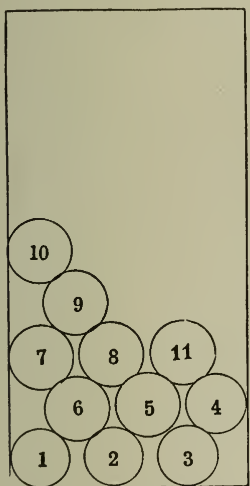
[W. E. Sawyer, photo.
PLATE VIII.—OFFSET THREE-TWO PACK.

[W. E. Sawyer, photo.
PLATE IX.—OFFSET THREE-THREE PACK.

the middle. Place two apples in the spaces thus formed to make the next cross row. The third row will require three apples, and the layer is finished by making diagonal rows across the box. The apples in each layer to lie in the pockets formed by those below.

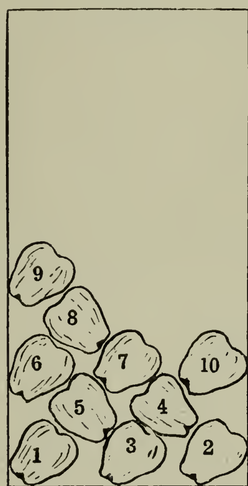
(*c*) *Three-three pack*—(See Fig. 3 and Plate VII.).—Each cross row has three apples in it. To start place one apple in the lower left hand corner. Then take two apples and place them so that they divide the space between the first apple and the right hand side of the box into three equal

FIG. 3.



DIAGONAL THREE-THREE PACK.

FIG. 4.



OFFSET THREE-TWO PACK.

divisions. Place an apple in each of these divisions for the second row and continue in a similar way to the "two-two pack" until the layer is finished. Begin the second layer by placing three apples in the pockets formed by the first six apples of the first layer and continue as before. Build up the third and fourth layers in the same way.

(2) OFFSET—(See Figs. 4, 5 and Plates VIII. and IX.).

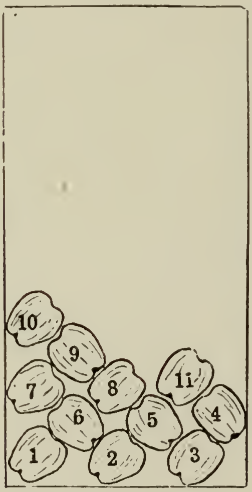
The apples are placed on their sides, so that this method is suitable for tall or pointed apples and also for those which have a handsome cheek. The fruit when packed this way travel as well as when packed diagonally. This method is

only suitable for small and medium sized apples. Boxes of large apples seem incompletely filled.

(*a*) *Three-two pack*—(See Fig. 4 and Plate VIII.).—This is similar to the diagonal pack of the same name in that it is used for medium-sized apples, and has in each cross row alternately three and two apples.

The box is started by placing the first apple on its side in the lower left hand corner so that the eye points into the corner. The second is placed in the right hand corner so that the cheek faces the corner, and the direction of the eyes is similar to that of the first apple placed. The third apple

FIG. 5.



OFFSET THREE-THREE PACK.

FIG. 6.

STRAIGHT FOUR PACK.

of the row is placed equidistant from the first and second and pointing in the same direction. The two apples of the second row are placed facing the opposite direction. That is apple No. 4 is placed so that its eye fits against the cheek of No. 2, and its cheek into the stem hollow of No. 3. Apple No. 5 is placed similarly, so that its eye is against the cheek of No. 3, and its cheek in the stem hollow of No. 1.

The apples in the third row are placed in the same direction as the first row, and so that the cheeks fit into the stem hollows and the eyes are against the cheeks of the apples in the second row. This method is continued until the other end of the

box is reached, the layer being made rigid in a similar way to that adopted for the diagonal packs. When apples with handsome cheeks are being packed, care must be taken that the apples are placed with the colour downwards, so that this is shown when the box is opened. The second layer is started by placing the first two apples in the pockets formed by the first three of the first layer, but so that the apples point into the opposite corner. The remaining layers are begun and finished in the way previously described.

(*b*) *Three-three pack*—(See Fig. 5 and Plate VIII.).—This method is used for the small apples, three being placed in each row in the manner described for the previous pack.

(3) Straight Pack—(See Fig. 6.).

In this style the rows of apples run parallel to the sides of the box. Unless grading is perfect it is extremely difficult to get a tight pack with a good crown. The apples themselves can be placed either on their side or with stem or eye up. The best packs always have the bottom and top layers with the stems towards the wood. The disadvantage of this method is that the fruit often get slightly bruised—more so than with the diagonal or offset, on account of all the apples of the outside rows touching the wood of the box.

Apples which, when packed in the straight method in "standard" box give five layers deep, will when packed on the "diagonal" or "offset" systems give a space of about half an apple between the last layer and the top of the box.

To determine, therefore, into which sized box the apples will pack more easily, when using the "diagonal" or "offset" methods, place apples of the average size one above the other up the side of the box. For a good "diagonal" or "offset" pack to fill the box well, the last apple will stand half out of the box. Select the box which gives most nearly this result.

Beyond the directions already given, it is impossible to say into which box the general varieties of apples grown will pack more satisfactorily, as the relative height and breadth of apples vary according to the locality in which they are grown.

It is sufficient to say that all apples can be packed in the stated boxes if well graded. It has been found that apples with a smaller diameter that $2\frac{1}{4}$-in. will not pay for packing.

THE KENT COMMERCIAL FRUIT SHOW.

By R. Wellington.

It is a matter for congratulation that only a year has elapsed from the mention of the idea to the actual holding of the first Kent Commercial Fruit Show.

The suggestion was made by the Principal at the Fruit-grower's Conference, held at Wye College, on December 2nd, 1910. The first show was held at Ashford, in conjunction with the Ashford Fat Stock show, on December 11th and 12th, 1911.

The aims and objects of the show are briefly as follow :—

(1) The advertisement of home-grown fruit, with the object of creating an increased demand.

(2) The introduction of better systems of packing and grading fruit, in order to ensure delivery in the best possible condition. The packages to be so labelled that they are of known quality and content.

The demand for fruit by the general public has been considerably increased within the last few years. Large quantities of American and Colonial fruit, comprising apples, pears, plums, bananas, etc., are now shipped to this country, and their disposal has necessitated extensive advertisement. Constantly one sees notices in the papers of the quantities of bananas which have arrived at Bristol, the number of ship-loads of Tasmanian or Australian apples on the way to this country, the magnificence of the Colonial fruit shown at such and such an exhibition, and so on. Such notices keep this produce before the eye of the public, and are largely obtained in return for advertisements inserted in the various newspapers and journals.

This general demand for fruit by the British public is comparatively recent. It is within the reach of the British fruit-grower by similar means, combined with better methods

of distribution, to participate largely in its supply. The Kent Commercial Fruit Show will be one of the means to this end.

It is intended that the Show be migratory throughout the chief centres in the South-Eastern Counties. Its full value will not be tested however until it has been held in London or some other such centre within the reach of large numbers of the consuming public.

For the public to realise the high quality of home-grown fruit, it is necessary to show it to them in large quantities. This can only be attained by the continued and increasing support of British Fruit Growers. Exhibitions of English apples on a commercial scale are so seldom seen that it is scarcely surprising that a large section of the general public visiting the Show at Ashford, on finding themselves confronted with an array of boxes of clean grown apples expressed their admiration at the wonderful display of Canadian fruit.

Throughout the Show the fruit was packed in non-returnable wooden boxes of either of the following dimensions.

"Federation Standard":—20 ins. long, 11 ins. wide, 10 ins. deep.

"Federation Special":—18 ins. long, 11½ ins. wide, 10½ ins. deep.

These boxes have a capacity of about 40-lbs. nett of fruit, and are already familiar in the London and Provincial markets as the packages in which a considerable portion of the Foreign and Colonial dessert apples arrive.

The following is a description of the various classes:—

Classes open to Bona-fide Commercial Growers in the County of Kent.

Class I.—Bramley's Seedling Apples. Five boxes. Twenty-five entries.

1st Prize.—Mr. C. S. Smith, Boughton Monchelsea, £5.
2nd Prize.—Mr. W. L. Hubble, Faversham. £3.
3rd Prize.—Mr. W. W. Berry, Faversham. £2.

The season was undoubtedly unsuitable for this variety, the majority of the exhibits in this class being off condition. The first prize fruits were of medium size, good colour and well packed; those awarded the second prize were green and

in good condition, well graded and packed, but small. On this account there was some criticism of the judging and the incident called attention to an undoubtedly weak point in the particular score card used by the judges, namely: too few points being allotted to typical size. The score-card and suggestions as to possible improvements are dealt with later. At the sale by auction on the second day, conducted by Messrs Garcia, Jacobs, & Co., of Covent Garden, the first prize lot was sold at 15s. per box. The average price per box for the class was 4s. 9d.

Class II.—Newton Wonder Apple. Five boxes. Twenty-four entries.

1st Prize.—Mr. S. Smith, Barming. £5.
2nd Prize.—Mr. W. W. Hubble, Hunton. £3.
3rd Prize.—Mr. A. Miskin, Chart Sutton. £2.

The fruit exhibited in this class was undoubtedly the finest in the Show. The packing, however, was below that of any other class. An exhibit which attracted much attention, owing to the excellence of the fruit, was undoubtedly the worst packed, and showed at a glance that proper packing is a totally different operation from what may be termed "putting in boxes."

The poor packing of the exhibits in this class was probably due to the presence of the lemon stem, characteristic of this variety, which increases considerably the difficulty of packing. Newton Wonder is, however, a variety which is much enhanced in appearance when well packed.

The first prize lot was sold for 15s. per box; the average price per box for the class being 5s. 10d.

Class III.—Lane's Prince Albert Apple. Five boxes. Sixteen entries.

1st Prize.—Mr. W. L. Hubble, Faversham. £5.
2nd Prize.—South-Eastern Agric. College, Wye, £3.
3rd Prize.—Mr. A. Miskin, Chart Sutton. £2.

Although some fine fruits were exhibited in this class the majority were not in the best condition owing to the early season. The first prize lot was sold for 8s. per box, the average for the class being 4s. 6d.

Class IV.—Blenheim Orange Apple. Five boxes. Twelve entries.

1st Prize.—Mr. W. W. Berry, Faversham. £5.

2nd Prize.—Mr. W. W. Hubble, Hunton. £3.

3rd Prize.—Mr. S. Smith, Barming. £2.

The first prize lot was sold at 8s. per box, the average price per box for this class being 6s. 10d.

Class V.—Any Dessert Apple (not Blenheim Orange). Three boxes. Twenty entries.

1st Prize.—Mr. W. L. Hubble, Faversham. *Variety:* King of the Pippins. £3.

2nd Prize.—Messrs. Gaskain & Whiting, Faversham. *Variety*: Cox's Orange Pippin, £2.

3rd Prize.—Mr. S. Smith, Barming. *Variety:* Cox's Orange Pippin, £1.

This class attracted a large number of entries, the varieties including Cox's Orange Pippin (the greatest number), King of the Pippins and Baumann's Red Winter Reinnette. Some surprise was expressed at the first prize going to a superb exhibit of King of the Pippins. Although the fruit was only of a good medium size, the condition, colour, grading and packing of these boxes were perfect. This exhibit showed to what excellence King of the Pippins can be grown on some soils. The second and third prizes were awarded to exhibits of Cox's Orange Pippin, which, although very beautiful, were relatively not of such fine quality for the variety when compared with the first prize exhibit.

The first prize lot made 10s. per box; the average price per box for Cox's Orange Pippin being 12s., for King of the Pippins 6s. 9d.

Class VI.—The Best Packed Box. One box. Twenty-four entries.

1st Prize.—Mr. S. Smith, Barming, £1.

2nd Prize.—South-Eastern Agricultural College, Wye, 10s.

The boxes in this class were shown at first nailed up, and branded or labelled ready for market. They were opened during judging.

The packing in this class was in the majority of cases excellent. The awards were made to boxes packed without wood-wool or paper between each apple or layer, the only packing material considered necessary being a thin layer of wood-wool at the top and bottom, with packing paper up the sides. That packing material other than the above is unnecessary was well demonstrated by the condition of the fruit in the prize boxes. So long as the apples are well graded and packed tightly, they will travel perfectly. The labels, however, were as a rule not very attractive. It is necessary for them to have a striking and unique design which is made more "showy" by printing on highly finished paper.

CLASSES OPEN TO BONA-FIDE COMMERCIAL GROWERS IN THE COUNTY OF KENT, GROWING LESS THAN TWENTY ACRES.

Class VII.—Bramley's Seedling Apple. One box. Eight entries.

1st Prize.—South-Eastern Agricultural College, Wye, £2.
2nd Prize.—Mr. G. Studd, Sittingbourne, £1.
3rd Prize.—Mr. C. Bates, Mersham, 10s.

It is a matter for regret that these small growers' classes were not better supported.

Whereas the boxes in Class I. seemed to show that this apple is not displayed to the best advantage when packed in these boxes, the exhibits in this class refuted this idea, and the box taking first prize showed that the "pack" pre-eminently suited to this variety is that termed the "offset." Not only do the apples look much better when packed by this method, but the extreme greasiness of this variety, generally a drawback to good packing, is overcome. The first prize box was sold for 8s., the average price for the class being 5s. 2d. per box.

Class VIII.—Lane's Prince Albert Apple. One box. Four entries.

1st prize.—Mr. C. Bates, Mersham, £2.
2nd prize.—Major W. Nicholson, Sutton Valence, £1.

This was the smallest class in the show.

Plate I.

Photo] *De'Ath & Condon.*

General View of Show.

Bramley's Seedling on right, Newton Wonder on left.

Plate II.

Photo] *De'Ath & Condon.*

General View of Show.

Lane's Prince Albert on left; Dessert Apples and Bottled Fruits on right.

PLATE III.

Photo] [Young & Cooper.

SOME OF THE EXHIBITS IN THE CLASS FOR THE BEST PACKED BOX.
Note the various packs and packing material used.
No. 121, the box winning First Prize. No. 122, that winning Second Prize.

Class IX.—Any Dessert Apple. One box. Ten entries.

1st prize.—Mr. F. H. Wheeler, Marden, £2.
2nd prize.—Mr. H. E. Hutchinson, Staplehurst, £1.
3rd prize.—Mr. G. Hilder, Rolvenden. 10s.

The first prize box was sold for 16s.

OPEN TO RESIDENTS IN THE COUNTY OF KENT.

Class X.—Bottled Fruits.—One dozen quart bottles. Five entries.

1st prize.—South-Eastern Agricultural College, Wye, £2.
2nd prize.—Mr. W. Usmar, Maidstone, £1.
3rd prize.—The Horticultural College, Swanley, 10s.

OPEN TO COMMERCIAL GROWERS AND NURSERYMEN IN GREAT BRITAIN.

Class XI.—A Cooking Apple in Season. One box. Thirty-nine entries.

1st prize and Champion Cup for best box in show.—Messrs. Gaskain and Whiting, Faversham, £2 and Cup.
2nd prize.—Mr. A. Miskin, Chart Sutton, £1.

The variety shown by Messrs. Gaskain and Whiting was Annie Elizabeth. This box was later awarded the Champion Cup for the best box of apples in the show. The exhibit was a superb one, the packing being so good that the apples arrived with no blemish whatever. The fruits were of good size, very even, clear and of excellent colour. A box of Wellington, exhibited by the same growers, was thought by some to be of equal merit. The exhibit taking second prize was an even and well packed box of Newton Wonder.

In this class the following varieties were exhibited:—Bramley's Seedling, Newton Wonder, Annie Elizabeth, Wellington, Mère de Ménage, Tower of Glamis, and Lane's Prince Albert.

At the sale the champion box made the fancy price of £3 10s. or about 1s. per apple. Messrs. B. Shearn & Co., of Tottenham Court Road, London, were the buyers.

The average prices per box in this class were:—

	s.	d.
Bramley's Seedling ..	5	2
Newton Wonder ..	6	2
Wellington	8	0

Class XII.—A Dessert Apple in Season.—One box. Twenty-four entries.

1st Prize.—Messrs. Gaskain and Whiting, Faversham. *Variety :* Cox's Orange Pippin, £2.

2nd Prize.—Mr. J. Redmond, Loughgall, Co. Armagh, Ireland. *Variety :* Gascoyne's Scarlet Seedling, £1.

This class composed the finest collection of dessert apples in the show, the judges finding considerable difficulty in awarding the prizes. The following varieties were exhibited in this class : Cox's Orange Pippin, average price per box 13s. 9d. ; King of the Pippins, average price per box 7s. 9d. ; Gascoyne's Scarlet Seedling, Barnack Beauty, King of Tompkin's county.

Class XIII.—A New Dessert Apple, raised since 1900, *in season after December* 1*st. Half bushel box. Five entries.*

1st prize.—Mr. A. J. Thomas, Rodmersham, £5.

The variety shown being Houblon. The other varieties shown in this class included Rival and an unnamed seedling.

Class XIV.—A Collection of twenty-five Maiden Fruit Trees on Crab Stock.

The Cup given in this class was won by Mr. J. W. Todman, of Platt Nurseries, Borough Green, Kent, the trees having exceptionally fine root systems.

In all there were 217 exhibits comprising 539 boxes, having an aggregate nett weight of about ten tons of fruit.

Messrs. W. G. Lobjoit, C. S. Martin, and T. J. Poupart performed the arduous task of judging. They received directions to judge the exhibits from the commercial standpoint entirely, according to size, uniformity, colour, condition and pack of the apples. In Class VI., that for the best packed box, 75 per cent. of the points were to be given to the packing, including the design of the label or brand. The packing included uniformity of the apples, compactness, alignment, and attractiveness of the finished box.

After some discussion the judges awarded points as follow:

Uniformity of apples in the box ..	30
Condition (freedom from bruising, etc.), packing (attractiveness, etc.) ..	30
Colour	20
Size (Commercial Standpoint only) ..	20
	100

This score card, however, proved not quite satisfactory, and the judges have since made up the following schedules which may be compared with one used in the great apple exhibitions of the Pacific States of America.

	Mr. Lobjoit.	Mr. Poupart.	American.
Fruit—			
Size ..	10	25	10
Colour ..	10	15	20
Condition ..	20	25	20
Quality ..	—	—	20
Total for Fruit ..	40	65	70
Packing—			
Uniformity of Grading	20	10	10
Quality of Pack	30	25	20
General Appearance	10	—	—
	100	100	100

With reference to his method of judging Mr. Lobjoit states the following: "Under the heading *Size and Colour*, conformity to type should be considered. In *condition*, the degree of ripeness for sale and the effects of travel. *Quality of Pack* means firmness and fitness for travel. *General Appearance* gives an opportunity of marking untidy paper, inharmonious colour, and appropriateness of the style of packing to the particular type of apple."

Mr. Poupart places *uniformity of grading* low in his card as it follows that the quality of the pack will largely depend on the grading and hence thirty-five points for uniformity and quality come under one heading.

In the American score card the twenty marks given for quality of the pack are again sub-divided as follows:—

Bulge	4
Height of ends	4
Alignment	4
Compactness	4
Style of Pack	4
	20

The particular merits of the above scores depend solely on the relative importance of the various headings. The number of points to be allotted to the actual fruits on the one hand, and to the packing on the other will always be more or less a matter of personal opinion.

The question of judging, however, raises a number of controversial points of much practical importance to the grower. The chief amongst these is the question of the crown or bulge obtained in packing. That a bulge is necessary at all is often disputed—it seems, however, absolutely necessary for several reasons. The chief point in its favour is that the spring of the lid produced by it keeps all the apples in the box tight and firm. If such is the case, and boxes are handled moderately carefully no bruising of the fruit will result. It will ensure that the box will open at its destination as attractive as when packed. When ordering box-wood growers should make a point of having the lids as pliable as possible and not thicker than $\frac{1}{4}$-inch, otherwise some bruising may result. In packing it must always be remembered that the apples tend to settle during transit, bringing about a considerable reduction in the bulge. This is especially noticeable with fruit packed on the "diagonal" method. Adverse critics of the bulge should, therefore remember that boxes which seemed at the Ashford Show to have a very slight bulge, had a much greater one when packed. The extent of the bulge, when first the box is packed, found to give the most satisfactory result is $\frac{1}{4}$ to $\frac{3}{8}$ in. on either side, being $\frac{1}{2}$-in. to $\frac{3}{4}$-in. above the side of the box before nailing.

Of the extremes above and below this extent—too great a bulge is the less harmful. The top and bottom layers in

this case will show a few bruises, whereas if there is no bulge at all every apple in the box will rattle when the box is handled and will become as much bruised as is often the case when packed in bushels. The apples in the top layer will become turned and out of place, destroying the evenness and attractiveness of the package.

Closely bound up with the question of the bulge is that of the extent to which packing material such as wood-wool should be used. Nearly every grower has his own method, a fact well illustrated at Ashford. Of the exhibits some had only a thin layer of wood-wool or a sheet of corrugated cardboard on the top and bottom of the box, outside the packing paper; others had the fruit actually set in wood-wool; others again used corrugated cardboard round the sides and so on.

Experience gained during the last season shows that the less packing material used the better. Besides the packing paper, a thin layer of wood-wool at the top or bottom is all that is necessary—always provided the packing is well done. If the packing is loose much more packing material will be required, and the top layer will never have an even and attractive appearance. The layer of wood-wool already mentioned may be replaced by a piece of corrugated cardboard, this not only saves much time but also avoids covering the fruit with the dust and small particles of the wool. The use of wood-wool between the layers of fruit or between each fruit takes a considerable time and moreover destroys the chief advantage of using a standard box, since it converts it into a package of unknown quantity so far as buyers are concerned.

The colour and quality of the packing paper for the sides, tops, and bottoms of the box are again dependent on the fancy of each grower. Some essential points, however, may be mentioned. The packing paper should be of an absorbent nature, moderately thick and with no shiny surfaces. White and blue seem to be the only suitable colours. Pink certainly does not blend with the colour of the fruit. White seems preferable for dessert varieties; whereas blue, although disliked more or less sentimentally by buyers, has distinct advantages for cooking apples. It may be mentioned that Bramley's Seedling if at all greasy will dirty white paper, and

make it look extremely unattractive, while blue paper shows little effect and tends to show up the fruit.

When packing apples in boxes was first advocated, it was mentioned that the smaller apples would have to be classed as seconds and would then realize a poor price. From a glance at the various exhibits at Ashford and especially those in the class for Newton Wonder, it was at once noticeable that so long as the fruit was clean and of good shape, the medium and smaller sized apples gave a more attractive pack. From this it may be mentioned that so long as the sample of fruit is clean and of known variety, so long can the fruit be economically packed in boxes.

The question of obtaining a suitable non-returnable package for large cooking apples remains yet to be decided. A number of buyers favour a headed barrel similar to that recommended by the Board of Agriculture and Technical Instruction in Ireland. This barrel is of a standard size, and is already used to a large extent by Irish fruit growers. The chief drawback at present seems to be its cost, but undoubtedly this will be reduced as the demand for the package increases. At present these barrels cost growers 1s. 8d. F.O.R. at Portadown, Co. Armagh. This compares with 1s. 6d. which is the cost of a similar barrel in Nova Scotia, the package so well known in Covent Garden and other markets. It is proposed to have an exhibit of the barrels at the forthcoming show.

A point of important detail in commercial apple packing is the securing of a suitable label, the use of which gives each grower's produce a distinguishing mark. The up-to-date grower is then able to prove the quality of his produce, and create a demand. The labels should be of sufficient size to quite cover the end of the box. Their attractiveness is greatly increased if they are printed in one or more colours; photographs of several are given on Plates IV., V., VI. and VII. It is essential that the label appear striking. A label, although designed with good taste, may appear dowdy when seen at the market amidst the brightly labelled foreign packages. Labels which are highly coloured and glazed, although slightly more expensive, are to be recommended.

TYPES OF BRITISH APPLE BOX LABELS.

PLATE IV.

Photo] [*W. H. Hammond.*

LABEL USED BY MR. O. ELLIS, BRAMLEY, GUILDFORD, SURREY.

The Spaniel is coloured deep brown, the remainder being printed in various shades of green.

PLATE V.

Photo] [*W. H. Hammond.*

LABEL USED BY MR. J. MORTER, LINGFIELD, SURREY.

The fruits are coloured green with red streaks; the bands are black, while the words "English Apples" are in yellow. The background is shaded blue.

TYPES OF AMERICAN APPLE BOX LABELS

Plate VI.

Photo] [W. H. Hammond.

The above is an extremely striking label. The apples are in yellow, the diamond in deep blue, while the background is scarlet.

Plate VII.

Photo] [W. H. Hammond.

The apples in the above are deep red, the words are in light blue, while the background is printed in yellow.

At the Fruit Grower's Conference held in conjunction with the show, Mr. C. S. Smith read a paper on "The Packing and Grading of English Apples." He gave the cost for the packing as follows :—

Cost of the box	5d. to 6d. each.
Making up	2s. per 100.
Packing approximately	$1\frac{1}{2}$d. per box.
Total Cost of Packing and Package	7d. to 8d. per box.

At the same Conference Mr. E. S. Salmon read a paper on "Apple Scab and its control by Bordeaux Mixture and Lime Sulphur," (see p. 408 of this Journal).

This year's show will be held at Maidstone, on Tuesday and Wednesday, October 29th and 30th. The earlier date allows the inclusion of classes for the apples Lord Derby and Worcester Pearmain, together with a class for pears.

The chief classes have been opened to growers throughout Great Britain; this should largely increase the number of exhibits, besides allowing the other fruit growing districts opportunity of exhibiting their methods of packing and grading.

THE FRUIT GROWERS' CONFERENCE.

HELD AT THE CORN EXCHANGE, ASHFORD, DECEMBER 11TH, 1911.

A Conference of Fruit Growers took place in the Corn Exchange under the presidency of Lord Northbourne, who was supported by Mr. M. J. R. Dunstan (principal of Wye College) and Mr. E. S. Salmon. A large and representative number of fruit-growers attended from all parts of the county and other fruit-growing districts. Amongst those present were Dr. Wilks, Miss E. Bradley, Messrs. Selby Smith, S. Mendell, W. Nash Vinson, H. Mount, P. C. Mount, S. W. Mount, T. Hubble, C. S. Smith, F. C. Bradley, H. T. Edmonds, S. May, W. H. Skinner, J. T. Hatch, C. Igglesden, E. J. Colthorp, R. Mitchell, G. E. Champion, G. Bensted, —. Waddell, J. C. Farmer, E. J. Howard, S. E. Sanderson, T. J. Bowes, R. E. Jenkinson, W. Miskin, A. H. Sharp, W. D. Bayley, W. C. Hills, F. W. Dalton, E. C. Kerr, T. Oliver, A. F. Corfe, H. F. Ash, F. Maylam, F. Jenkins, H. E. Hambrook, E. Fowler, L. S. Gardener, A. Fairwether, A. Bath, C. W. Norton, G. Gregory, H. Crowhurst, A. E. Emslie, R. M. Emslie, L. W. Laslett, B. G. Berry, W. Rogers, W. Body, H. Harbour, H. L. Webb, W. D. Elgar, T. D. Harris, C. R. Smith, T. A. Wimshurst, T. and T. G. Gillett, R. King Smith, H. Stonham, S. Skelton, J. Harvey, E. Cheeseman, W. G. Chandler, Hy. Mount, P. Manwaring, S. Swinford, G. A. Batchelor, W. F. Osenton, G. Branchett, F. Butcher, H. T. Barnett, R. Ferguson, F, Duncanson, W. Farmer, J. Highwood, E. J. Harvey, L. R. Richards, W. A. Nicholson and many others.

His Lordship aptly opened by saying they had met on business, and reminded them of an old edition of Munday's "Guide to Kent." "The county of Kent," the handbook stated, "could be divided into three portions. There are three

places where you will get health and wealth, health without wealth, and wealth without health." The latter was in the famous Romney Marsh, a prosperous district, which had since gone through some hard times, but through its grazing properties, sheep, which were fatted there, attained larger prices than any others. Health without wealth was in the district where he lived, on the Downs, where corn was grown, and cold, unresponsive soil was found, but where there was plenty of fresh air. Health and wealth was that portion of Kent called the Garden of England, where fruit and hops were grown, and they could grow anything they pleased. There were, however, many changes since that book was published, and he thought there were certain signs of an agricultural revival, and to nothing could be attached greater importance than the cultivation of fruit, upon which they had met to confer. This was due to Professor Dunstan and his co-adjutors at Wye College. They lived in an age and circumstances under which agriculture rested on a scientific basis, and it was due to that scientific knowledge and careful observation that they saw the results to-day. The proof of it was in the adjacent building, in which was the finest show of apples that had ever been shown in the British Isles. However much they studied the properties of soil, etc., everything in the long run depended upon the individual, either men or women, and he was inclined to think that the women would take a very favourable part in the industry.

Mr. Dunstan introduced a memorial to the Conference and explained that a large sum of money from the Development Fund had been granted to the Commissioners for aiding agriculture. It was rumoured that an institution for the prosecution of research and investigation work on fruit-growing and treatment of plant diseases was to be established in the West of England. He considered the industry of fruit-growing in Kent was of sufficient importance to be considered, and he urged them to become signatories to a memorial to the Board of Agriculture to have such an institution in their midst and for their benefits. The memorial was as follows :—
"We, the undersigned fruit growers, learning that there is to be established in England a research institution for carrying out investigation in fruit-growing, including the practical

treatment of plant diseases, desire to urge upon the Board of Agriculture the very strong claims which Kent possesses for the establishment of such an institution within its borders as being the county containing a larger and more rapidly increasing acreage of fruit than any other county in the United Kingdom."

Mr. E. S. Salmon, of Wye College, gave a paper on "Apple Scab and its Control by Bordeaux Mixture and Lime Sulphur," A reprint of this paper will be found on p. 408 of this *Journal.*

After luncheon, in the absence of Lord Northbourne, Professor Dunstan opened the proceedings, and introduced Mr. C. S. Smith, of Wye College, who read a paper on "Grading and Packing of English Apples." The system he explained was the one used by the majority of American and Colonial growers, although he did not advocate the abolition of the bushel and the barrel, but advocated the use of the box for first quality fruit of certain varieties. The box was the best package for first quality apples of standard varieties, but particularly dessert varieties, the bushel for second quality fruit, and, as a rule, for varieties which were not well known on our markets. He urged them to use the boxes adopted by the National Fruit Growers' Federation, which would settle the question of standard sizes. The box had two important points in its favour. First as a distinct package for first quality fruit only, for when buyers knew they can rely on the contents of English boxes, it was bound to create a big demand. Secondly it enabled a grower to gain a reputation for his fruit, which was almost impossible when he only sent in a salesman's empties. The most suitable varieties for the boxing were, he thought, Beauty of Bath and Worcester Pearmain. Ben's Red had paid better than any others, though he had also done very well with Bramley's Seedling and Bismarck. The early dessert apples would be our most satisfactory varieties for boxing, but he advised growers not to attempt to pack Gladstone or other soft apples in boxes. Grenadier, Stirling Castle, Lane's Prince Albert and Newton Wonder were the most suitable cooking varieties for the purpose, though any variety could be packed in boxes provided the price was right. Failure was generally due to the following reasons :—Packing unsuitable or unknown varieties. Not

grading and packing them properly, and not selling them properly. The shipping companies and the large stores would handle a very large quantity of English apples if they could obtain them well graded and packed in boxes, but they did not want bushels. He advised growers to sell by sample at the outset.

Apples intended for boxing should be carefully picked and graded at once, whether they were to be packed immediately or not. Mr. Smith then clearly described the packing of the apples, the chief point being that the apples must be tight, though not too tight, and on the cheek instead of the eye or stem. On the top and bottom layers of wood-wool should be laid, and then the box nailed up on the press. The box should be stamped with the name of the variety and the number of apples in the box. To arrive at the cost was difficult, but he estimated it at 5d. to 6d. each for boxes, and the cost of making up at 2s. a hundred, and packing approximately at 1½d. per box. The speaker showed some boxed apples which had done two railway journeys and exemplified the utility of the scheme.

With the assistance of two students a demonstration of apple boxing was given and aroused the profoundest interest amongst those present. Later, Mr. Salmon repeated his paper, taking the place of Mr. F. V. Theobald, who was unfortunately a sufferer from influenza.

THE HOP GARDEN.

By C. S. Smith.

This season a severe early blight occurred which made it necessary to wash the hop garden four times, after which there was little trouble from this cause. A considerable quantity of mould appeared directly the hops came into burr, but this was kept in check by means of frequent sulphuring. Continual cultivation was necessary on account of the drought. The garden produced the satisfactory total of fifty-two pockets of Goldings and five pockets of sundry varieties.

The fifty-seven pockets realized the satisfactory price of £9 15s. per cwt., 86 cwt. net being marketed from the $5\frac{1}{2}$ acres of commercial hops, and a small part of the experimental garden.

THE VEGETABLE AND GLASSHOUSE DEPARTMENT.

By H. C. Chapelow.

The crops on the whole have been good.

Potatoes.—These turned out well, and free from disease. No spraying was done.

Peas.—These grew well up to the middle of July, when they gradually dried up, and all the later sowings for succession were quite a failure.

Beans.—French Beans were a good crop. Runners and Broad Beans were both very poor.

Onions.—These were raised in frames, and transplanted in the open early in April. No water was given, but they were frequently hoed. This treatment resulted in an excellent crop, in a season when the onion crop generally was below the average.

Other varieties of vegetables (with the exception of Celery and Lettuce) were of average quality.—Seakale, Brussels, Cauliflower, Broccoli, Savoys, etc., did not suffer through the dry summer, and were in good condition.

The Glasshouses.—Tomatoes were the principal crop. Nothing could have suited them better than the hot dry season. The plants averaged a little over seven pounds of fruit.

The Frame Ground, " when not in use for raising tobacco," was used for Lettuce, Radishes, etc., and to raise plants for the vegetable garden.

FORESTRY.

BY A. H. J. HAINES, P.A.S.I.

During the past year the new nursery has been properly established, and stocked with several thousands of trees of various ages, including :—Scots Pine, Spruce, Willow, Ash, Black Walnut, Quercus rubra, Cerris pedunculata and Sessiliflora, European Larch, Japanese Larch, Silver Fir, Birch, Beech, Alder, English Elm, Wych Elm, Cupressus macrocarpa, Hornbeam, Thuja gigantea, Sycamore, Douglas Fir, Pinus gerardiana, Corsican Pine and Austrian Pine.

With the exception of a mild attack of *Chermes Pini*, which was treated and the loss of most of the Cupressus macrocarpa from spring pests, the season has been a satisfactory one.

The areas under crops at the present time consist of 1½ acres of mixed plantations (Oak, Ash and Spanish Chestnut) established in 1905-6 ; ½ acre of Ash 1908-9 ; 1½ acre Spruce 1905-6 ; 1 acre Corsican Pine 1909-10 ; 1 acre Scots Pine 1909-10 ; 1½ acres of Coppice with Oak Standards ; and ½ acre of Coppice. There is also a small Arboretum. It was found impossible to plant up the proposed acre of Larch and Beech mixed, of even age, in 1910-11, and this will be carried out in the coming year.

BEE-KEEPING.

By J. Garrett.

The apiary has had a much more satisfactory season than for some years past. The 1910 season left the hives at a very low ebb, but the fine summer of 1911 caused honey of fine quality to be gathered very rapidly, almost too rapidly for brood rearing.

REPORT

ON

ECONOMIC ZOOLOGY.

FOR THE

YEAR ENDING SEPTEMBER 30th, 1911.

BY

FRED V. THEOBALD, M.A., F.E.S., Hon. F.R.H.S., etc.

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INTRODUCTORY NOTE.

This Annual Report covers some of the observations made and received from correspondents from October 1st, 1910, to September 30th, 1911. The greater part of the year has been spent in investigating Aphides, which form one of the most important groups of insects the agriculturist and horticulturist and forester have to contend with. The work so far has been almost entirely collecting and sifting out the various species found in Kent, but thanks to several correspondents in different parts of Britain, Europe and Africa, much other material has been collected. At present one hundred and sixty-four species have been found in Kent alone. Lists and notes of these have been issued in the *Entomologist.* In addition some ten species have been found apparently as yet undescribed.

Several important facts regarding the genus *Macrosiphum,* one of which is very harmful to peas (*M. pisi* Kaltenbach), and the genus *Pemphigus* which attacks trees have already been found out, which have considerable economic importance in dealing with them.

It is thought best to retain these observations and to issue them in a fuller form than usually appears in this report.

Some 2,000 microscopic preparations have been made in connection with this group of insects.

No new fruit pests of any importance have to be recorded, except the attack on apples of one of the *Argyresthias,* known as *A. conjugella* of Zeller.

Owing to the Board of Agriculture scheduling the Narcissus Bulb Fly (*Merodon equestris*) considerable attention has been paid to it by nurserymen and others. As pointed out in an article on this fly, it is widely spread over Britain and occurs in a wild state. Moreover an equally serious bulb pest, the larva of an allied fly—a *Eumerus* has been found to

be very common, and in many cases as bad if not worse than the larger *Merodon.*

The subject of *Strongylidæ* in sheep has been handed over to Mr. Bruce Gardner, B.A., who will shortly issue a preliminary report on this important subject.

My thanks must be expressed to Mr. C. O. Waterhouse, I.S.O. ; Mr. Distant, F.E.S. ; Mr. Claude Morley, F.E.S.; Mr. E. Austen, F.E.S. ; Mr. Gahan, M.A., F.E.S. ; Professor Schouteden, Professor Tullgren and Professor Newstead for help given me in identifying specimens.

Mr. Edenden of Wye, as usual has taken the photographs illustrating this report with the exception of three kindly given me by Mr. Blakey.

FRED. V. THEOBALD.

ANIMALS INJURIOUS TO FRUIT TREES AND BUSHES.

The Codling Moth (*Carpocapsa pomonella* Linnæus).

The Codling Moth (*Carpocapsa pomonella* of Linnæus) is such a well-known fruit pest that it seems unnecessary to refer to it. I do so, however, for one or two specific reasons. Formerly it was a serious enemy in this country to not only apples but pears, and I have once or twice found it quite harmful to walnuts; a habit which it also has in America. It has in recent years declined in numbers to a very marked extent. This is probably due to three causes, namely: (i.) the cleaner state in which our plantations and orchards are kept; (ii.) to arsenical spraying and (iii.) to the much smaller quantity of maggotty fruit sent from abroad to this country. It is by no means extinct, however, far from it, and while it lurks about in small numbers we never know whether or not it may spring up in epidemic form. Such frequently happens I have noticed when anything out of the normal takes place in the life cycle, such as I shall describe has taken place with the Codling Moth in the past year.

The Codling Moth has found its way to every part of the world where apples are grown, and in other countries than Europe it has proved a very serious pest.

At one time great quantities reached this country in imported fruit. In 1902 and 1903 I examined numbers of barrels in London and found some to be swarming with maggots. In the same year a barrel opened in Wye was found to contain dozens of the larvæ, many of which had crawled out and spun up in a backyard. In the same year a complaint was made by a correspondent of the Board of Agriculture from Smithfield Market, Manchester* of the danger of these

* First Report on Economic Zoology (Brit. Mus.), 20. 1903. F.V.T.

constant fresh importations. From the markets they were traced back to the plantations in two cases, travelling in the returned empties. There is no doubt that this invasion was serious. Since then the number of maggotty apples sent to this country has steadily decreased, and the last few years I have only found them in apples exported from Portugal, some coming from that country where the maggot is very abundant, and others from the Azores and Madeira.

In Natal all cases of Portuguese and other apples infested with this pest are destroyed ; during 1903 large quantities were burnt. (*Natal Journal of Agriculture and Mines*, Dec. 1903.)

As they have decreased in foreign imported fruits so have they in our plantations. Up to 1905 the maggot was very harmful in many districts. Up till then I had frequent complaints from Surrey, Devon, Somerset, Uttoxeter, parts of Worcestershire, Middlesex, Sussex, Herefordshire.

I have had no complaints since 1905 until the past summer and autumn, when it was reported from Herefordshire and Sussex. It also appeared again at Wye in considerable numbers in my own garden, and I found a number of affected apples on the College Farm. It does not appear to have occurred in the latter neighbourhood since 1902 ; previous to then it was very common. It was stamped out on the College Farm by banding, and I entirely cleared it out at Wye Court by the same method. A few must have remained in some old isolated trees and have started to increase again, or foreign importations may account for the re-appearance.

The interest in two cases reported last year and in observations made at home lies in the fact that there was a marked second brood. This anomaly which I have only known to have occurred once before in this country,* may point to the insect once more being in the ascendant.

The life history is briefly as follows :—

The Moth hatches out at various times in May and on to June.

The female lays her eggs on the side of the young apples, now and then on a strig, rarely on a leaf with us.

* Report on Economic Zoology for the year ending April 1st, 1906, p. 24, F. V. Theobald.

The egg, is flat, fish-scale shaped and round with a reticulated or sculptured shell, semi-transparent and shiny.

As a rule only one egg is laid on each fruitlet. A single female may deposit over 100 eggs.

The caterpillar hatches in from six to nine days, and the young caterpillar crawls to the eye or calyx cup, where it feasts for a short time on the skin inside the eye. This is what I have always observed in this country. In America, however, Simpson* and others have found that some of the first brood may enter the apple anywhere, piercing the apple and making a shallow mine just under the skin, and points out that these mines can be told at once by the lighter colour and the excrement cast out from them. Nevertheless they have found that 60 per cent. enter the calyx, whilst in subsequent broods from 60 to 90 per cent. enter at any part of the apple. The second brood, which appeared copiously last year, invariably entered by the side, and left very characteristic pale mines, which were in circumscribed areas about as big as a threepenny piece; these had a hole in the middle from which frass was expelled, and later these patches turned to brown decayed spots, quite spoiling the fruit. (Plate I.)

In the early brood the larvæ at the end of four or five days, leave the calyx, and tunnel into the pulp, forming an irregular gallery, gradually increasing in size until the larva reaches the core. When it gets to the core it excavates around it, eats the pips and leaves behind a mass of frass and silken threads.

The maggot stage with us lasts a good three or four weeks, whilst in America it takes only from ten to fourteen days according to Simpson, from twenty to thirty according to Slingerland. On nearing maturity the caterpillar eats a larger tunnel outwards and keeps the exit hole blocked with wet frass and silk.

The larval Codling Moth can be told from other apple maggots as follows:—in length it is about half of an inch, its head is brown, the body creamy white to pink, each segment with darker spots, from which proceed small hairs, on the first three segments are three pairs of brown jointed legs, on the next two none, on the following four are four pairs of pale

* Report upon an Investigation of the Codling Moth in Idaho in 1900. Bull. 30. N.S. U.S.A. Dep. of Agri., Div. Ent., pp. 51-63.

prolegs or sucker feet, there are also prolegs on the caudal segment.

When the larvæ are mature they clear the frass plug from the exit hole, and then either fall from the fruit, lowering themselves by a silken thread to the ground and re-ascend the butt or trunk of the trees, or else they may leave the fruit and crawl down the branches to the trunk. Some may also fall with the maggotty apples.

In all cases they strive and most attain their object, to get back to the trunk of the tree and there, as soon as they come across any shelter, they settle down and spin a coarse cocoon under any rough bark, moss, lichen, or in a crack or hole.

If the tree trunks are very smooth, some may enter the pupal stage in cracks in the soil, or in grass orchards amongst the grass or under clods of earth.

The cocoons are of a thin silk, of a dirty colour, mixed with wood chips and frequently in a hollowed out space. Now and again I have found them of a cleaner silk, and devoid of wood *dêbris*, but I have been unable to connect this difierence as has been pointed out in America between the first and second broods.

If the first brood is going to give rise to a second brood, the larvæ must change into the pupal stage rapidly. I have not observed this change in Britain but it must take place. However, I have a note in an old diary of 1887, of finding many pupæ in my father's orchards at Kingston-on-Thames, in the late summer, the Codling Moth being one of the worst pests we had to contend with, and I distinctly remember finding many apples, especially amongst the Ribstone Pippins and a large yellow Codling I have not seen since, with the diseased patches caused by the second brood figured here. At that time I did not know the cause of this appearance. If there is only one brood, which is the usual life cycle in this country, then the larvæ remain as such until the spring in their cocoons.

Those of the second brood do likewise. The first time I observed a second brood was in 1905, when I succeeded, under normal outdoor conditions, in hatching out moths in August which I easily got to deposit eggs on apples, the ova hatching in six days and the maggots entered the fruit at the base. The

larvæ matured by October 10th. During the same year the late Mr. Getting sent me many Codling Maggots from Ross during the last week in September, which were abundant in Cox's Orange Pippins, Mr. Getting noting that they had entered either at the side or base of the fruit. The pupa which is found in the cocoons in the spring is of a yellowish brown colour. I have never observed them "bronze" as described by Simpson in America (Idaho), its segments are armed with spines, and by means of these it wriggles itself out of the cocoons, and from under the bark. The pupal stage I have found in Britain lasts a few weeks only, but in America it is said to last about eight months. I have found maggots under the bark until the end of February, and a few even in March. The moth has a wing expanse of about three-quarters of an inch; the fore wings are brownish crossed by lines of brown and grey scales, and near the corner of them is a large bronze coloured spot; the hind wings are grey. The male can be told by having a streak of black hairs upon the upper surface of each hind wing, and on the under surface of each front wing is a long, blackish spot.

The moths fly mainly at night, when they lay their eggs, but some may be found at twilight. During day time they rest on the trunk, branches and sometimes leaves. When on the two former their coloration is so protective that they are most difficult to discern.

Abroad the number of broods may reach at least four. The greater the number of broods of course the greater the damage, and hence we are placed at an advantage in this country.

Effect of Parasites and Enemies.

I have only found one parasite on this moth in Britain, and I have known it now for thirty years.

On the other hand one need only watch such birds as the Blue, Great and Cole Tits to see them picking the larvæ out of their winter cocoons to recognise what value they are. I have also found the larvæ in the crops of Chaffinches, and have once seen the Nuthatch clearing them off an old apple tree.

In parts of Europe it is parasited by a hymenopterous insect—an Ichneumon, called *Ephialtes carbonarius* (Zach.) notably in Spain, the female laying her eggs in the grubs

in the cocoons. These parasites, I fear, are of little practical value ; for further reference to this subject I refer readers to my work on "Fruit Pests."*

Prevention and Treatment.

This is simple and sure. The Codling Moth can be easily controlled by spraying with Arsenate of Lead, it can be soon stamped out by banding the trees. Nothing can be done for the second brood which enter the side, etc., of the fruit.

If Codling Moth appears in an orchard of standards or half standards in two years you can stamp it out by banding the trees with sacking or patent paper, so largely used in Germany and other continental countries.

The process is simple. It is to tie around the trunk or butt of the tree in May, or any time before, a piece of sacking (old manure sacking will do) in two folds, the under tied above and below, the upper left loose below. If one has large trees invaded, then it is worth while to band the larger branches just when they reach the trunk, but this is only an exceptional necessity.

These bands should be taken off in winter and burnt. I I have found as many as seventy pupal cocoons under a single band. By this method I know the pest was cleared from the College Farm, from my own trees at Wye, and by Mr. Bickham at Ledbury, whilst abroad it is the common procedure.

The patent paper referred to here is also largely used. I have only one fault to find with it, and that is its cost. For three years I have used it for grease-banding. I thought it would last two or three years on old trees, but the Tits and Woodpeckers came at it so hard for the store of insects it caught that by the spring many of the bands were useless.

Nothing is better to spray with for Codling Moth than Arsenate of Lead. The thing is to know when to spray. To be successful your spraying must vary with the variety of apple owing to the difference in blossoming. To be successful one must spray soon after the blossom has fallen ; leave it later than two weeks and you do no good at all, it should be

"* The Insect and Allied Pests of Orchard, Bush and Hot-house Fruits," p. 77. 1909.

done within the week after the blossom has fallen, to give any good results. Do that, and the Codling Moth can be easily controlled. When one considers the number of varieties of apples that one sees grown together in Britain the difficulty of successful spraying naturally presents itself under such circumstances. I think that if this insect, as it has done many times before, rises into prominence, growers had better be prepared to keep it down by trapping than deal with it in the successful way it is fought in America, where fewer varieties are grown, by spraying.

The Small Apple Fruit Moth

(*Argyresthia conjugella* Zeller).

Some apples found by me in South Devon, in 1910, were found to be riddled with small tunnels in the flesh which had penetrated to the core. In two I found small Tineid larvæ which answered to those described as *Argyresthia conjugella*. The moths hatched out during my absence and in consequence were so badly rubbed that I could not identify them with any degree of certainty.

Mr. Britten had observed a similar attack in Cumberland, which he called attention to at the Hexham Fruit Congress and has hatched out the moth. He then referred to the maggots as dipterous larvæ. It was feared they might prove to be the American Apple Maggot (*Trypeta pomonella*). Later I wrote to Mr. Britten and had the following reply :—

"On returning from the show (Hexham) I at once set about getting hold of affected fruits to get the grubs, but was too late for the maggots which I am still sure were there when I first noticed them, but in a few fruits from different places I got a Lepidopterous larva which in all probability will be the *Argyresthia*. There was a difference in the burrows, the maggot first noticed had very thin sinuous tracts, like brown threads, and appeared seldom to penetrate very deeply into the fruits, at least seldom reaching the core. The burrows of the moth larvæ nearly always reach the core, and frequently there is a heap of frass inside the core, but the seeds were not eaten, the burrows were also much stouter and the exit hole larger."

It thus appears that we have two other larvæ attacking the apple besides the well known Codling Moth and the Apple Sawfly.

I know of no British dipterous insect that is likely to attack the fruit in this way, and it is hoped Mr. Britten will hatch out the dipterous larva in Cumberland and show us what it is.

The presence of the Tineid Apple Miner, *Argyresthia conjugella*, is not to be unexpected.

Similar diseased apples were sent me some years ago from near Ramsgate.

This moth has been recorded in this country many times by the few people who collect these fragile insects. Stainton, in his "Manual of British Lepidoptera," Vol. II., p. 370, refers to it as occurring in the berries of the mountain ash in the larval stage in August.

The attack on the fruit is very marked, the larvæ making small tunnels just under the skin, then into the flesh, and then eat the pips; the tunnels are very tortuous and almost impossible, I found, to dissect out. They become brown and then black, and the flesh just around becomes discoloured by their excrement. Britten found that the seeds were not eaten. In those I examined they certainly were, and an amount of wet brown frass was present. Three larvæ were found in one fruit, but from the tunnelling and the numerous exit holes seen in the specimen photographed, it appears that several may inhabit one apple. (Plate III.)

The larvæ (Plate II. b.) are dull whitish yellow, some dull pinkish, the head shiny brown, and the first segment dark, there were also traces of a dusky mark on the caudal segment. They have sixteen legs like the Codling Maggot, and may be mistaken for them, but they are much smaller, and their method of walking is quite distinct. On reaching maturity the larvæ left the apples on and about September the 4th, and spun up small oval net-work cocoons amongst some leaves placed with the apples and on the soil. The moths hatched out while I was away in September. Stainton records the moth in Britain as appearing from May to July. There thus appears to be two broods as with the "Cherry *Argyresthia*." The second brood of moths appear to lay their eggs and die.

Where the eggs are laid in the apple species we have not observed in England.

An old record of evidently the same insect is given by Warburton (Annual Report for 1898 of the Zoologist, *Journal Royal Agricultural Society*, 1899, p. 760).

His specimens were received in October, 1897, also from Devonshire. He mentioned that the borings exactly resemble the work of the much dreaded American *Trypeta pomonella.* In 1898 Mr. Warburton visited the farm, and after careful search at last found the larvæ of a Tineid Moth. He states that the larvæ did not agree with the description of those of *A. conjugella.* The following interesting observation was made, namely that *apparently* the same caterpillar frequently emerges from the apple and enters it again at another point. In bad cases he found the core had always been reached and one or more of the pips excavated as I found to be the case.

Argyresthia conjugella occurred in 1896 in great numbers in British Columbia. At least the moths bred from this region were identified as *A. conjugella* by Lord Walsingham.

This insect is well known in Sweden as attacking apples (*Vide* " Uppsatser Praktisk Entomologi ").

The plate (No. II.) reproduced here for reference is from figures kindly given me by Professor Tullgren.

From one of the photographs of attacked apples shown here it appears the larva first works under the skin of the apple and in so doing forms a distinct patch, not unlike but much smaller than that formed by the second brood of Codling Moth. (*Vide* also Plate II. c.)

Stainton's description of *Argyresthia conjugella* is given below for reference.

" Fore wings purplish fuscous, with the inner margin whitish, interrupted beyond the middle by a dark fuscous spot, nearly opposite to which is a *dark fuscous spot on the costa*; on the costa towards the tip are two whitish spots. Length six lines ($=\frac{1}{2}$ inch)."

It is recorded from York, Scarborough, Newcastle-on-Tyne, Manchester, Birkenhead and Brighton by Morris in Vol. IV. of his *British Moths* and by Stainton from the Lake district of Cumberland and Westmoreland, as well. In the Insects of Kent from Plumstead, West Wickham

and Bexley and in the Natural History of Hastings and St. Leonards as not uncommon in the vicinity (1878).

As no treatment is known for this pest abroad and nothing rational from what we know of its history seems likely to be done, it is most important that any appearance of it in a plantation should at once be stamped out by the destruction of all infested fruit.

Semi-Winged Female Tineid Moths.

The females of the family *Exapartidæ* are not wingless but they have their wings so small that it seems they are unable to use them for flight. These moths (placed by Morris in the family *Epigraphidæ*) have fully winged males, but in the females they are abbreviated and pointed, except in one genus *Semioscopis*. In the genus *Exapate* the female has no hind wings at all, in *Chimabacche** there are short, narrow hind wings. The larvæ of these moths have sixteen legs and can be told by the third pair being club-shaped.

During the last year quite a number have been sent from fruit trees, the females being caught in grease bands in March and April.

The only one received and found in any numbers is *Chimabacche fagella* (Plate IV. b.). In April (16th) females were sent, by Mr. Lake, from Mortimer, Berks, with a note that they were on black currant bushes. Others were received a few days later from near Worcester and from Middlesex. On April 18th I found several in grease bands on cob nuts; the first appeared in my garden on April 2nd, crawling up apple trees.

The female (Plate IV. b.) is greyish, the front wings very pointed and narrow, not as long as the body, the hind pair very short and narrow, the female is about two-thirds of an inch across the wings. The male is about an inch across the expanded wings, the front pair being dull yellowish, dusted with brown, with a dark transverse bar and two rather obscure dark spots near the middle, the hind wings are paler and uniform in colour.

* In Richard South's "Synonymic List of British Lepidoptera," 1884, p. 28, this insect is placed in the genus *Diurnea* Haw.

The larvæ are dirty green to grey, with pale, almost yellow, heads, and can be told by the structure of the legs; they are about half an inch long. I found them in June and July. Stainton records them in September and October, so it appears to be double brooded.

They feed between the united leaves of a large number of trees and bushes. Stainton says on most trees. I am not aware that it has been definitely recorded before on fruit trees and bushes. Those from Mortimer were on black currants, those from Middlesex on apple and pear, and I found them at Wye on cob nuts, apples, and one on a cherry trunk.

The larvæ spun up in July, forming an open network like cocoon of elongated form. None of the moths unfortunately hatched out. Tullgren (Uppsatser Praktisk Entomologi," 21, p. 73, 1911) records an allied species in Sweden (*Exapate congelatella* Cl.), and mentions that it feeds on Berberis, Ligustrum, Crataegus, Prunus spinosus, Pyrus, Salix, Ulmus, Ribes, Rubus idæus, Rhamnus and Syringa.

The Vapourer Moth (*Orgyia antiqua* Linn.).

This moth appears to have been very abundant in parts of Kent during the past year.

Numbers of egg masses laid by the wingles females on their cocoons were sent in January by Mr. R. Tester, from East Peckham, and in the same month Mr. Arnold, of the same village, sent another consignment, saying that his apple trees contained a good many such deposits on the dead leaves caught up in the branches, etc. Many were also found on leaves which had held on to the trees.

Others were received from Faversham in similar condition.

An enquiry concerning the larvæ was also received in September, from Taunton, Somerset.

The Pale Brindled Beauty Moth (*Phigalia pilosaria* Hb.).

The caterpillars of the Pale Brindled Beauty Moth (Plate V. c.) were sent on the 22nd of May, from Hailsham, Sussex, where they occurred in some numbers. Two were also found on an apple tree at Wye, on May 20th. The only other records I have of this moth on fruit trees are from Loddington, Maidstone, and an unrecorded place in Sussex.

A full account of it was given in my last Report, pp. 16-17, and Plate II.

The wingless females may be caught by keeping the greasebands on until the end of April or by using Tanglefoot, which lasts over nine months in a sticky condition.

The Green Pug Moth (*Eupithecia rectangulata* Linn.).

Many enquiries were received in 1911 concerning the larvæ of the Green Pug Moth (*Eupithecia rectangulata*, Linn.). Mr. Miskin, of Chart Sutton, wrote, on May 23rd, that he had been catching great numbers of them in bands of Tanglefoot left on the trees. I noticed the same at Wye, as many as twenty being found in one band. This was after one of the few showers of rain we had during that year. Whether they were shaken by it off the trees or not I do not know, but it appeared as if this was the case. The green larvæ, with dark stripe down the back, of this moth now and then seem to occur in considerable numbers on apples, and spin up the blossoms, eating them and the leaves and do no little harm.

At the time one usually sprays for Winter Moth they are too tightly housed to be affected by the arsenate of lead, but I have found that with nicotine and soap (1 oz. nicotine, 2 ozs. soap, to 10 gallons of water) many were destroyed. The soap carries the nicotine into all manner of crevices, especially if rain follows the spraying and so gets at the sheltered larvæ.

Apple Blossom Weevil (*Anthonomus pomorum* Linn.).

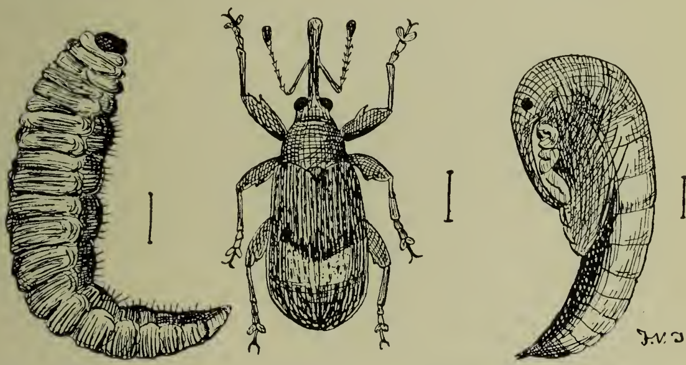
Numerous complaints of this pest have come again from Worcestershire, Gloucestershire, Cambridgeshire and Devon.

Mr. Westrup, of Haddenham, Cambridgeshire, writes me that Bandite Tanglefoot accounts for a good many, but that he was not always successful in shaking them off the trees, as they appeared to hold tenaciously.

No preventive has yet been found for this serious pest. The German method of banding with special paper has not been properly tried in this country, although it appears to have met with much success in Germany. The cost of the paper seems to put growers off using it. But surely it would be worth trying a few rolls to see if it does catch the beetles here as it is said to do abroad. If it does and they do so

much harm, the expense, if it stamps them out, would be nothing.

Pupæ were received from Penshurst, on May 18th, and another enquiry showing the great damage done by the larvæ of this beetle was received on May 24th, from Messrs. Jackson and Sons, Sittingbourne. Mr. King Smith, of Platt Farm, Borough Green, also wrote in May, complaining that he was pestered with this beetle.



i. Larva. ii. Adult. iii. Pupa.

FIG. I.

THE APPLE BLOSSOM WEEVIL (*Anthonomus pomorum* Linn.).

On the other hand, Mr. Ivo. Neame, of Faversham, found that although there was a sprinkling of this insect in his orchard, it was not nearly so virulent as during the last two years. This he suggests was due probably to the earlier blossoming than usual and also on account of picking 'capped blossoms' in the previous year. This weevil was also sent me from Exeter, Devonshire, where it also seems to be very common.

The Raspberry Beetle damaging Apple Blossom.

A fairly general attack of the well known Raspberry Bug or Beetle (*Byturus tomentosus*) was reported in 1911 upon apple blossom. The beetles appeared in great numbers in many places, and fed not only upon the internal parts of the

blossoms, but devoured the petals which even when eaten in small holes turned brown, and decayed, many remaining sticking together. Beneath these dead and dying petals the beetles sheltered, and it was found it was difficult to dislodge them.

Typical damage caused by them is shown in the photograph of apple blossoms reproduced here. (Plate VI.)

It is impossible to spray at the time they are working, and all that can be relied on is jarring the trees, and shaking them off on to tarred sacking. Even this did not prove entirely satisfactory, as so many of the beetles were too firmly held back by the petals that were damaged. But if this is done very large numbers may be destroyed, especially if on a bright day. No other treatment is likely to be effective.

Mr. Martin wrote on May 8th, concerning this pest as follows :—" To-day we have found the first *Byturus*, not on raspberries but quite plentifully in apple blossom, the raspberries not, it seems, being forward enough."

Leaf Weevils (*Phyllòbius oblongus* Linn.).

It is now well-known that under certain conditions the Leaf Weevils, especially *Phyllobius oblongus*, may do considerable damage to young fruit trees, grafts and buds. In 1910 and 1911 Mr. Westrup, of Haddenham, Cambridgeshire, found them to be swarming on both apples and plums. but more on the latter.

He found that they are readily shaken down and caught on cloths, and he also noticed that great numbers were caught in Bandite Tanglefoot. There is no doubt that the best way to deal with this pest is to shake the trees so that they get caught in the Tanglefoot on their reascending. I have seldom seen this species active on the wing, most of them crawl, and this accounts for the great numbers seen in May and June in grease bands (often mistaken for Apple Blossom Weevils).

They not only damage grafts and buds, but do endless harm to the foliage.

The Apple Twig Cutter (*Rhynchites cœruleus* De Geer.).

This small blue Weevil has been more noticed than in previous years. Writing from Haddenham, Cambs, Mr.

Westrup says as follows :—" Twig Cutters have been a dreadful pest to my trees. They started the first week in May, and are still at work (June 27th). I found that H. Emulsion deterred them at 1 in 100, but it scorched the leaves. I then used it 1 in 150 and had to renew every three days."

It was also sent from Thanet and from Hereford. At Wye it was not only more abundant than usual, but continued to work on the trees for a much greater length of time than usual.

A New Fruit Weevil (*Hypena punctata* Fab.).

Specimens of the Weevil called *Hypena punctata* Fabricius, (Plate IV. c.) were received from Mr. S. D. Lake, of Mortimer, Berks, on May 29th, who had found a number on his apple trees. Mr. Lake thought he noticed one feeding on an Aphis, and also that where the beetles occurred there were very few plant lice.

Later, however, he found that this was wrong, and he wrote me that the Weevils which had been fairly common, were doing harm.

Bugs (*Hemiptera-heteroptera*) Damaging Apples.

The curious " scabby " growth seen on young apples which I had previously ascribed to Thrips (*vide* Report, 1911) is also without doubt produced by several species of Land Bugs, or Plant Bugs (*Hemiptera-heteroptera*).

Those I collected at Mr. Best's at Suckley, Worcester, were in larval and nymphal stages, but only two nymphs matured. Others were sent me by Mr. Best and Mr. Alexander. These have been named by Mr. Distant, the chief authority on *Hemiptera-heteroptera*, as being Reuter's *Crthotylus marginalis*, a species closely allied to *Orthotylus flaviventris* Rbm., and from which it is said to differ structurally by the genital forceps in the male being " not three pronged, but the left side produced into two long prongs." In *O. flaviventris* the male has the right side of the genital forceps " three pronged."

Both occur on *Salix*.

I also took several species of *Lygus pratensis* Linnæus at Suckley, on the apple trees.

Dr. MacDougall informes me that the following bugs came to him in connection with this damage from Worcestershire,

viz., : *Psallus ambiguus* Fallen, *Plesicoris rugicollis* Fallen, *Ætorhinus angulatus* and *Philænus spumarius*. The last two, he says, were probably accidental.

A similar attack to that seen in Worcestershire was reported from East Peckham by Mr. Frank Smith. The apples chiefly attacked were Charles Ross and they were hit very badly, scarcely any other sorts growing with and near them were damaged. Numbers of green bugs were sent, which Mr. Distant identified as *Orthotylus marginalis*. This latter species is one of those that injure the currant and apple leaves in a similar way to the damage done by the Yellow Springtails.

In Norway the attack of *Orthotylus marginalis* and *Plesicoris rugicollis* on currant and apple foliage is very common. Professor Schoyen writes me : " Where they puncture the young leaves, often to an enormous extent, they produce a most marked appearance and the bushes and trees suffer materially." The damaged leaves he sent me exactly agree with the damage seen on the apple leaves at Suckley.

These bugs when immature puncture the tender growths, and cause them to curl up and become stunted. When they do grow away the punctures appear to split, the result is the leaf is not only deformed but much perforated. In some cases to such an extent that they die. The damage done to the foliage is nothing however compared to the harm done to the young fruit which the larvæ and nymphs also puncture.

The same damage occurred again in my garden to apples and plums as in 1909 and 1910 ; almost daily beating and search did not give a single hemipteron, but again two of the trees were laden with Thrips and here the fruit was similarly scarred, but there was no leaf damage. On the other trees washed with nicotine no damage was done and no live Thrips were to be found. Hemiptera were undoubtedly the chief cause of damage at Suckley, as very few Thrips were present when I visited the plantations of Mr. Best, and he informed me he only found them in numbers on a few trees. In the attack in Kent nothing but the green *Orthotylus* was present, and that in considerable numbers.

Although the life history of these insects have not yet been followed in England, it is probable that it is the same as that of allied species in America.

In a paper on the "Apple Red Bugs,"* Professor C. R. Crosby, of Cornell, describes and figures just such an attack as that seen in Worcestershire and Kent, the damage to fruitlets and leaves being identical. Two species of bugs appear to do the harm, namely the Capsids known as *Heterocordylus malinus* Reut. and *Lygidea mendax* Reut. (Two species described by Reuter in Acta Soc. Sc. Fennicæ xxxvi., pp. 47, 71, 1909).

Their eggs are laid in June and July, and are inserted their full length into the bark on the smaller branches, two year old wood being preferred. They are most difficult to find. Four eggs seem to be laid in each cavity in *H. malinus*, and they were especially found at the base of the fruit spurs. In *L. mendax* they were usually inserted in pairs in the lenticels of smooth two year old wood. The eggs diverge at a wide angle. The eggs hatch soon after the leaves of the fruit buds open, and hatching is practically complete by the time the blossoms open.

The False Red Bug (*L. mendax*) hatches a week later.

These remarks are probably helpful in further investigation on the British pests.

The young Green Bugs found on the trees here work in similar manner, the small larvæ in the opening buds, and working on as nymphs until the fruit is well set in the same way as the American Red Bugs.

Treatment.

It is obviously out of the question to try and kill them in winter in the egg stage, if they, as we may assume is the case, pass it as the American Red Bugs do.

The use of lime-sulphur wash to coat, and so kill them as they hatch failed in America.

Experiments were made against the young nymphs with lime-sulphur 1 in 30. *None* were killed, unless the spray was so copious as to drown them ! Soaps (whale oil, etc.) seemed also to be of no value ; nor kerosene emulsion. Nicotine preparations were effective, namely, Black leaf 1 to 65, Nicofume 1 to 700, Black-leaf 40, 1 to 816. The experimenter

* Bulletin 291. Cornell University Agr. Exp. St. of the Coll. Agri., Div. Ento., Jan 1911.

found that adding 2-lbs. of soap to 50 gallons of the liquid made it spread better.

This is exactly what I have found with nicotine, it can be reduced to at least $\frac{3}{4}$-oz. if soap at the rate of 3-ozs. is added to every 10 gallons.

From what I have seen in this country with the Bug *Lygus pratensis* and the Needle Nosed Hop Bug (*Calocoris fulvomaculatus*) they may easily be killed in their larval and nymphal stages with nicotine and soap alone at the rate of nicotine $\frac{3}{4}$-ozs., soap 3-ozs., water 10 gallons.

At Mr. Best's they were all killed where I saw spraying taking place with a mixture of paraffin, nicotine and soap.

The same spraying will kill Aphis, Apple Sucker, Thrips and *young* Caterpillars when the nicotine is used.

The Apple Sucker (*Psylla mali*, Sch.) (Plates VIII. and IX.)

Although this pest and its treatment are now well understood nevertheless numerous enquiries continue to be received.

On May 28th a complaint came from Old Malden, Surrey, of damage to apples. The cause was clearly Apple Sucker.

From Orpington an attack of Apple Sucker was reported which proved to be one of the Green Bug.

Enquiries were also received from growers at Swanley, Faversham and Canterbury.

Spraying in February with lime and salt continues to show its good effect upon this pest in spite of adverse criticisms of certain growers who say they find the salt does harm. It does not do nearly so much harm as the useless and persistent winter washing with caustic washes, used too frequently to trees that are perfectly clean. From what I have seen since 1893, lime and sulphur, now the rage, is quite impotent against this pest. It is, however, being reported as destroying insect eggs just as a patent wash was said to do some few years back. Trials I have made for many years show it to be just as harmless to them. Shrivelled Aphis' eggs occur now on unsprayed trees just as they did when a patent wash was supposed to have killed them!

Thrips (*Euthrips pyri* Daniel **on Fruit.**) (Plate X.)

These insects, which were fully reported in the last Annual Report, were sent me by Mr. Wm. Bear, of Hailsham, Sussex,

on March 23rd. Mr. Bear stated that they were appearing in great numbers in the opening fruit buds, and he feared would do much damage, especially on Irish Peach and Beauty of Bath, which were just showing in clusters partly out of their sheaths. He was killing them with soft soap and quassia. This insect was also enquired after from Faversham, Kent, and Toddington, Gloucestershire.

A *Thrips sp.?* was also sent from Gloucestershire, and several places in Kent that was attacking Loganberries. They occurred in great numbers and attacked the inner parts of the blossom shrivelling them up, the anthers were particularly damaged, some as shown in Fig 2 had black specks on the petioles, others (Fig 2 B.) were shrivelled up at the tops. Soon after these appearances occurred they died right away. Many of the blossoms looked as if they had been severely bitten by frost.

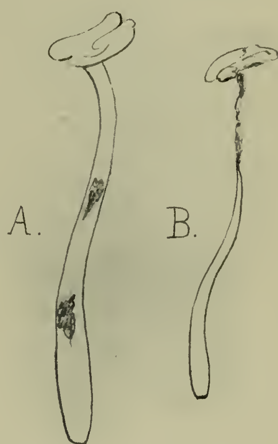


Fig. 2.
Damage by Thrips.
Enlarged anthers of Loganberry.

The insects were placed on bunches of sound blossom, and soon commenced to produce the marked appearance figured.

I was unable to identify this species, so append for reference a description of it.

Winged Female.—Thorax pale ochreous-brown, abdomen black. Head ochreous-brown with a rich brown patch between the black eyes. Antennæ black at the base, then ochreous-brown, and black on the apical half; pubescence pale, also pale on the wings. Chaetæ of abdomen black. Size that of *Euthrips pyri*.

Thrips appeared again in large numbers on two apple trees in my garden and on plums, but not until much later than usual. Many of the young plums dropped from their punctures on the strigs, and again many apples were noticed to be scarred in marked fashion. I could detect no difference

between this damage and that done by Green Bugs, except that on the Thrip attacked trees no harm was done to the foliage as it is when the Green Bugs are at work.

Apple Red Spider (Species Query).

Numerous attacks of this Tetranychus on apples have been recorded and many observed during the past year. It seems to be a much more serious pest than at one time imagined, owing to its undoubted increase during the last three years.

It is evidently not confined to the British Isles because Dr. Schoyen sent me ova and hatching young which he found abundantly on apple trees in Denmark. On the 26th of May Mr. Ivo Neame, Macknade, Faversham, found it swarming on some of his apples, and noticed at once that it was different from the Gooseberry Red Spider.

At Waltham Cross in Hertfordshire I saw a bad attack on young trees.

Writing from Haddenham, Cambridgeshire, in March, Mr. Westrup pointed out the vast number of red eggs on the apples. Most were laid at the junction of the shoot and the main stem, a few on the shoots near the buds. In all the appearance the Red Spiders cause is most marked, the leaves assume a curious pale, grey and rusty brown colour and the mites may then be found in swarms beneath the foliage. The worst attacks I saw were in August and September when little or no damage would be done, unless the attack becomes an annual one.

The pest, however, wants watching and if it persists and appears in numbers in the early summer as recorded by Mr. Ivo Neame it should be dealt with by spraying with paraffin jelly.

The Swallow Tail Moth (*Uropteryx sambucaria* Linn.)

The larvæ of this beautiful moth (Plate XI.) which were recorded in the last report* as doing damage to roses were found in March, 1911, by Mr. E. D. Lake, feeding on green apple buds and doing no little damage. He also found some eating the flowers off peaches on walls and the buds of cherries.

* Report on Economic Zoology for the year ending September 30th, 1910, p. 126. 1911.

The larvæ were sent by Mr. Lake, and eventually hatched out into the well-known Swallow Tail Moth.

It feeds normally on oak, ivy, elder and bramble.

Its occurrence on fruit trees shows how insects may change their food plants and habits at any time. It does not follow, however, that a change of this kind may become universal or may even occur again in the same locality.

Hop Damson Aphis (*Phorodon humuli*) on Apple.

One would not imagine that two aphides belonging to two totally distinct genera would live on the same host plant and be confused with one another. The Hop Damson Aphis (*Phorodon humuli*) (Plate XII.), which is quite distinct from *Aphis mahaleb* Koch, with which Miss Ormerod confused it, can at once be told on damson, sloe or hop by the processes on the head and basal segments of the antennae, which are absent in the Plum Aphides, *Aphis pruni*, *Aphis mahaleb* and *Aphis institia* and all four of the Apple Aphides.

The migration of *Phorodon humuli* from prunes, where it winters in the egg stage to hops in May and June is now well known, and as far as I can find from all previous records these were considered the only two food plants. Last year (1911), however, *Phorodon humuli* was found breeding in abundance in August and September on Apples in Wye village. At first I imagined these apple aphides must be a new species of *Phorodon* as none of this genus have been recorded on apple before. A detailed examination of them, however, revealed the fact that they were the common Hop Aphis which had made the apple its home with as much success as it does the hop or the damson and sloe.

The figures reproduced here are from specimens taken on apples at Wye last year, showing the exact characters of true *Phorodon humuli*.

They were not merely accidental visitors for they bred and multiplied at a great rate on the apple trees. I am fully convinced that at present we have not nearly solved the life history of the Hop Aphis, and this new record throws quite fresh light on the subject.

The eggs of the Hop Damson Aphis were first recorded as hatching in 1911 from Paddock Wood, Kent, by Mr. Overy, on March 10th, on damsons.

The Green Apple Aphis (*Aphis pomi* De Geer).

Great numbers of Apple Aphis were sent from Platt Farm, Borough Green, Kent, on March 28th, by Mr. King Smith, who found them swarming in the fruit buds. Mr. Overy also reported their hatching at Paddock Wood on March 10th. An enquiry was also received in June from Billingshurst, and others from Hailsham, on April 2nd. On March 31st numbers of young aphis were sent on buds from Monks Hill, Farnham, evidently hatched a few days, the grower stating he had just sprayed with Bordeaux Mixture. Many of the aphides were right inside the buds like Apple Sucker.

Enquiries were also received from Wickhambreaux, Canterbury on 19th of May, Bramley's being especially affected, and there were countless Bibio flies in the blossom at the same time, and also from Godalming, Surrey.

The advent of the Apple Aphis (*Aphis pomi*) wants carefully watching, as soon as they have stopped hatching out is the time to spray, *i.e.*, before they have started to curl up the foliage, when no spraying does any appreciable good, and is in fact pure waste of money. This hatching of the Apple Aphis is later than the *Psylla*, but the same spraying will be sufficient for both pests.

Black Aphis on Apples (*Aphis crataegi* Kalt.).

I have not until recently seen this aphis from apples. It was sent by Mr. G. D. Lake, from Mortimer, Berks, where he found it in great abundance on Lane's Prince Albert. This black Aphis is common on quick hedges and is quite distinct from the *Aphis crataegi* Kaltenbach, redescribed by Buckton, a green Aphis which I have renamed *Aphis crataegella*. The black Apple Aphis has the bases of the hind legs white. It curls the leaves up and appears from the case above recorded to flourish on the apple as well as on the hawthorn. It makes its appearance in May and June and continues until July.

CHERRY.

The Cherry Fruit Moth (*Argyresthia nitidella* Fab.).

This serious Cherry pest which I referred to in the last Report (pp. 38-39), as doing damage at Tibbs Court, Brenchley, was sent in May, by Mr. Lewis Levy, of Borden Hall, by Sittingbourne, with a note that they were attacking only the "Turk" Cherry, no other sort. It was also at work in cherry orchards around Borden Hall, and appeared to be doing a good deal of harm.

The little caterpillars eat right into the forming cherries, and quite ruin them.

Those kept under observation worked just as those kept last year, eating into the small fruitlets, hollowing them out, and then passing into others. One larva when nearing maturity devoured the contents of six cherries. They spun up their cocoons of scanty white silk from May 30th to June 12th. Moths commenced to hatch out two weeks later, and continued to do so until July 4th.

At Tibbs Court Eltons were most attacked, but others were to some extent.

The larvæ are pale, yellowish green in colour, when feeding inside the fruitlets they are often quite pale green, and have the normal number of legs. They all reached maturity in 1910 on May 18th, in 1911 those sent by Mr. Lewis Levy spun on May 22nd on till May 25th. When mature the larvæ are nearly one-third of an inch long. They pupated nearly a week after spinning. They mostly pupated amongst the dead fruitlets and the leaves around them, some on the sides of the box and others on a piece of bark placed in the box and on twigs.

The pupal stage in 1910 lasted from fourteen to eighteen days, in 1911 the first moth emerged only ten days after pupation and a second three weeks after. The cocoon is of a delicate open white network, common to all this genus of moths.

The moths hatched in 1910 from June 20th to 29th, in 1911 from June 13th to June 26th and two on July 4th.

The eggs are said to be laid close to the buds, and are presumed to remain there till next spring. It is thus possible

that lime and salt washing will check this pest, and also arsenate of lead spraying before the blossom opens.

The Cherry and Pear Bark Borer (*Semasia woeberiana* Schiff).

This insect seems to be gradually spreading in Kent, every year fresh localities being recorded.

Information concerning it was sought in 1911 by Mr. Bernard Pocock, bailiff to Messrs. Leney & Sons, of Pelican Farm, Wateringbury. The attacked trees had been planted six years, but the disease was only noticed in the autumn of 1910. The affected trees were not nearly so healthy and strong as those not attacked.

An inquiry was also received concerning it from Jersey, Mr. John Dunlop writing in March that the larvæ were doing much harm to a pear tree by burrowing under the bark of the main trunk and larger branches and were producing large exudations of frass and gum. A similar attack was recorded in my last report (p. 38) from Ashby-de-la-Zouch, the larvae attacking the trunk and lower branches only about two feet from where they joined the trunk.

Although I have not noticed this insect in the branches in Kent, it is clearly the same, the larvæ answering exactly to those found in the cherry trees in Kent.

The same insect appeared in 1911 in a large cherry tree at Wye, the larvæ were, however, soon got rid of by means of knife and wire.

CURRANTS.

The Currant Fruit Moth (*Spilonota roborana*, Tr.).

An attack of this insect was reported from Moat Farm, Ivy Hatch, near Sevenoaks, in May, 1911.

They occurred side by side with Winter Moth in the black currants, and while Swift's Arsenate of Lead Paste killed the latter it had no effect on the wriggling Tortrix larvæ. Unfortunately the attack was too far away to keep under observation and although the larvæ pupated normally the pupæ have all died.

The caterpillar spins the top leaves together, and also any leaves near the fruit, forming a tangled mass and at the same time eats into the currants. (Plate IV. A.)

It is hoped this year to follow out the life cycle of this insect in the field.

It will probably occur again as washing does not seem to have affected it injuriously.

The Currant Root and Elm Leaf Aphis
(*Schizoneura ulmi* Linn.).

The damage done by the Currant Root Aphis or Louse called S*chizoneura fodiens* by Buckton is not fully realized owing to its seldom being seen. It is but seldom reported owing to its retiring habits. In March, 1911, it was sent from Cheveney Farm, Hunton, with a note that it is frequently found in the soil when digging fruit platts, and a request was sent for information concerning its life history. On the following day another enquiry reached me from Exeter, Devon, on the same subject.

Mr. J. Udale, of Droitwich, also wrote on October 28th for advice concerning this pest, which had appeared in quantity on the currant roots.

This Aphis has its aerial form as the elm, where it is called *Schizoneura ulmi*. It may frequently be found doing much damage to elm foliage in summer by curling up the leaves and killing them. In August and September it becomes winged and flies about, settling on all manner of plants.

Specimens were taken at Wye on September 2nd on artichokes, plums, apples, ivy and hawthorn.

These winged females having been observed, observation was kept on currants, and it was soon found that many of them had collected around the roots of red currants, and were forcing their way into the loose parts of the soil. Some two weeks later the earth was scraped away and only the typical form of *Schizonenra fodiens* of Buckton were found breeding on the roots. A return migration was traced in May, when winged females emerged from the soil in numbers, and settled on the elm trees some couple of hundred yards away, and there they commenced to produce living young in very small numbers under the leaves. They later grew into the large

wingless *Schizoneura ulmi*, which shelters under the curled leaves, and produces numbers of living young.

Where elms are badly infested with this insect in the neighbourhood of currant plantations, it is advisable in early spring to hoe in Vaporite around the roots of the currants, and so kill the return migrant race to the elms.

Currant and Gooseberry Aphides (*Rhopalosiphum ribis* Linn. and *Aphis grossulariae* Kalt.).

A considerable amount of damage was done during the year to currants and gooseberries by Aphis. So called Green and Black Fly were present.

From Appledore, Kent, an enquiry and specimens were received on May 16th, both kinds being very abundant. Earlier in the week an enquiry of a similar nature came from Ramsgate, from Sir J. Kennard, who noticed the great quantity of ants present on the bushes.

The dark Aphis that curls up the top leaves of the currant and especially gooseberries is *Aphis grossulariae* of Kaltenbach.

Green Bug and Springtail Damage to Currants.

Currant leaves badly attacked by apparently both these pests were received on 19th of May from Botley, Hants.

Writing later in May, Mr. Lawrence, the Hants County Council Pest Inspector, said the damage was caused only by the Yellow Springtail.

Mr. F. Neame, of Faversham, also complained of this damage in May. He wrote saying "I have some red currants very much riddled at the top leaves, in several bushes the top shoots are dying off in consequence. I have noticed a tiny green bug on some of the shoots and leaves, but I doubt if he is the culprit."

There is no doubt that both the Yellow Springtails (*Sminthurus luteus*) and the Green Bugs (*Capsidae*) cause a very similar effect when they have been feeding on the young and tender currant leaves. Although I have never been able personally to trace their appearance to the Hemiptera, and one case mentioned here certainly refers to the *Sminthurus*, there is no doubt that there is a similar appearance produced by the Green Bugs. (Plate XIII.)

LOGANBERRY.

The Bramble and Loganberry Shoot Borer (*Aspis udmanniana* Linn.).

This bramble insect which I have previously recorded as attacking Loganberries was again reported in June, 1911, from Rayham, Whitstable, where it was infesting the plants for the first time.

There was also quite a noticeable attack on the logans on the College Farm.

The moth was figured and a short description given in my last Report, page 46 and Plate XVI.

The larvæ seem to be too tightly enclosed in the tips of the shoots and shut in by leaves to be affected by spraying, and nothing but picking off the diseased tips which always seem to be killed is likely to do any good.

As it appears to have permanently taken up its abode on the loganberry, it is well that it should be dealt with at once in a plantation, and not let get so far ahead that it cannot be stamped out.

PEAR.

The Egg laying of the Pear Midge (*Diplosis pyrivora* Riley).

Although the Pear Midge is one of the most destructive of fruit pests, and occurs over such a wide area in Europe and America, and has been monographed several times, I can find no detailed reference to its eggs and egg laying habits.

Although I have known this insect, formerly called, and I believe correctly, *Cecidomyia nigra* Meigen, since 1894, I have never seen until the past year more than a casual specimen or two of the adult. Nor have I met any naturalist or grower who has. Such a careful observer of nature as Mr. F. Smith, of Loddington, told me some time ago that he thought they must come of a night, oviposit, and then die. Although this is not so, the period of adult life seems very short as the following observations show.

An old pear tree about forty feet high in my garden became infested with the midge in 1904, since then up to 1910 it continually set well, but bore no or very little fruit owing to the midge.

I had never been able to find the midges and assumed they had hatched and flew at once upwards, and so out of sight.

In March 1911 I placed several large glass jars under the tree varying from two to twelve feet from the trunk, and these were examined every day. At last, on April 10th, I found two male *Diplosis pyrivora*, on April 13th there were many males and four females. On the 14th the females had much increased, but the males still predominated. Under one jar there were twenty-two males and fifteen females.

On the 15th another jar was counted, and there were twelve females and ten males. On the 16th there were very few males hatching, but several females under a fresh jar. On the 17th fresh placed jars revealed no specimens at all, and none occurred after.

At the same time I swept the grass with a net and obtained relatively the same results. On the 15th hundreds were caught under the tree, on the 17th I only got three after sweeping for four hours between seven and eight a.m., twelve and one p.m., four and five p.m. and six and seven p.m. The last occurred on the 18th.

Under another tree by sweeping I found hundreds on April 15th and 16th. The grass under this tree was sprayed with Abol and next day no midge could be obtained. A careful search showed many dead on the grass, killed by the spray holding them by their delicate wings.

In the open I found them resting on the grass, and on the wing low down under the trees, a few were seen to settle on the trunks up to three of four feet.

None were seen on the blossom until the 15th, and this usually towards the latter part of the day.

Some were also observed over and on the soil under another tree, and these were sprayed with soft soap and water, 1-lb. of soap to 10 gallons of water. This killed them just as well as the Abol on the grass.

Some males and females (Plate XIV.) were taken indoors and placed with fresh pear sprays in mouse jars, and watched with the following results. On April 15th two females in one jar oviposited. One female started to work at the unopened blossom with her tube at 5.29 and finished on this blossom in eleven minutes.

It took her previous to this exactly four minutes to insert her ovipositor. The second female took almost exactly the same time.

The ovipositor (Plate XV. C. and Fig. 3) was pushed through the sepals and not between them, and always at the side.

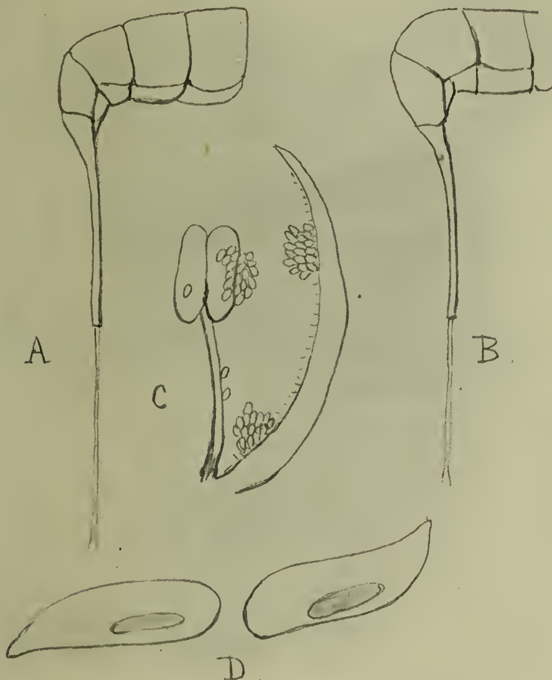


FIG. 3.

THE PEAR MIDGE (*Diplosis pyrivora* Riley.)

A. and B. Female oviposit or inposition for egg laying; C. ova in blossom; D. enlarged ova (shrunk in balsam).

During this act the abdomen curved at right angles, and was rapidly moved up and down in a boring like manner.

At completion of egg laying both females fell over as if exhausted, but resuscitated in a couple of minutes.

These same two females laid again in the day time, twelve and two o'clock respectively on both the 16th and 17th.

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On the 18th some females in another jar not carefully watched were still egg laying.

On the 19th all those in the jars were dead.

On the 18th I caught two females out of doors. None after careful sweeping on the 19th, when they all seem to have disappeared.

On the same day (19th) I opened a blossom in which the female oviposited on the 15th, and found forty ova, most in two large groups close together and a few scattered about.

The eggs were mainly attached in masses to the anthers or their strigs, but some were at the sides of the blossoms. They appear to hold firmly together by a moist substance.

The ova which are shown in the photograph taken by Mr. Edenden reproduced here are semi-transparent, very shiny, with an elongated eccentric yellow area. They are irregular in shape when viewed collectively. One end is rounded and the other has a short, blunt point in certain views.

On April 23rd another blossom which had been oviposited in was opened after the petals had fallen, and small larvæ were found huddled together in the embryo fruit.

Blossoms in which eggs had been laid opened some days after those which had not been struck in the jars. Whether this occurs in the open or not I did not observe.

It thus appears the egg stage lasts about seven days, as larvæ were found on the eighth day after oviposition had taken place.

A considerable number of inquiries concerning this insect were received in 1911 from Kent and Worcestershire. One grower, Mr. W. Vinson, wrote from Orpington, on May 24th, that the maggot had been very annoying again, his pears being much affected. One correspondent wrote saying that he had found the kainit treatment most effectual and that in two years the midge had been got rid of.

The midge was particularly attacking Bon Chrétiens at Suckley Mr. Best wrote and informed me.

PLUM.

The Bark Beetle (*Scolytus rugulosus* Ratz.).

This well known beetle was reported in December, 1910, from East Malling as destroying young standard Victoria

plums. Mr. Wilson, of Blacklands, stated that he had lost a good many trees last summer because of the white maggots found in them.

The specimen sent clearly showed the working of the Bark Beetle (*Scolytus rugulosus*). The tree was then quite dead.

Scolytus rugulosus is common in Devon, Worcester and Kent. The beetle attacks apples, plums, and pears, it is also recorded from quince, peach, nectarine and apricot.

The attack is easily recognisable by the small, round exit holes of the beetles. Whenever a tree is seen to be attacked it is wisest to cut it down and burn it in the winter, as there is no remedy. Dressings of soft soap and carbolic acid, of soap, soda and arsenic have been advised and if the trunk only is attacked in places this may be worth doing, but more often with us the branches both large and small are invaded, and then such dressings are out of the question.

Plum Fruit Sawfly (*Hoplocampa fulvicornis* Klug.).

This Sawfly seems to be spreading its attack further and further afield. Nearly full grown larvæ were sent by Mr. G. Champion, of Linton, on June 7th, with a note that it was common now in plums.

Others were received from Toddington in Gloucestershire, from Faversham in Kent and from Worksop.

No treatment is known for this pest any more than for the Apple Sawfly. It is certainly spreading, and if one only took the trouble to have all the fruit on a tree picked and burnt, and it in every case I have seen starts on a tree or two only, which makes this possible, it would not make or have made headway in a plantation. But of course if this is too laborious and too unpractical, well it must spread all over the plantation as it is sure to do, and then there is another pest as bad as the Apple Sawfly. As long as growers pass over these commencing attacks as of no account, because only one or two trees or fruits are eaten, and do not check such pests in the bud, they can only expect greater damage.

Gall Mites on Plums and Foliage (*Eriophyes phloeocoptes* Nalepa).

Reference was made to the presence of this mite in some numbers on plums at Evesham in my report to the Worcester

County Council and the danger of its possibly becoming serious was pointed out.*

Mr. Chambers drew attention to it in 1909, showing how the disease had got worse and worse. No attack on the fruit had been noticed, but Mr. Chambers found that the disease was "assuming such proportions as bid fair to attack every tree in the plantation."

On 28th of June, 1911, Mr. Ames, of Alfrick, Worcester, sent bunches of Pershore plums and foliage attacked to a serious extent as is seen in the photographs of them reproduced here. (Plates XVI. and XVII.)

I found it here and there in Worcestershire on plums at Evesham in 1906 and Suckley in 1911. It was also observed in one or two parts on wild prunes.

The same species I found in several localities in Herefordshire on sloes. In Kent it is quite common on bullace, in the hedgerows, and occurs on damson. One white damson of my own has been practically killed by the annual attack of this gall mite.

It manifests itself as small pale, wart-like blisters on the leaves, and as shown in the photograph may attack and seriously deform the fruit. In colour the galls vary to some extent, most are pale green to yellowish white, but may be reddish above, and become slightly hairy and rough.

The minute mites occur only in very small numbers in the leaf galls, not in swarms as we find in the Big Bud disease of currants. As the leaves die or become covered with galled areas the acari move to fresh parts of the leaf and to fresh leaves, and enter *via* the stomata or breathing pores and fruit. As shown here they may seriously damage the fruit. They lay a few rather large ova in the tissue of the leafage.

In autumn as the leaves dry off they move to the buds, where they pass the winter just under the bud scales in the same manner as the Pear Leaf Blister Mite (*Eriophyes pyri*).

This pest may fortunately be checked by spraying in the same way as for Pear Leaf Blister Mite.

One badly attacked tree was sprayed in February (24th), 1910, with lime, salt, caustic soda and sulphur wash, made

* Report on the Orchards and Fruit Plantations of Worcestershire. F. V. Theobald, 1906, p. 4.

as follows :—Lime 3-lbs., Flowers of Sulphur 3-lbs., Caustic Soda 1-lb., Salt, 3-lbs., Water 10 gallons.

The soda and lime are mixed together and slaked in hot water, in which the sulphur has been incorporated and finally when self-boiled brought up to 10 gallons by the addition of water.

As soon as the blossom had fallen the tree was sprayed with paraffin jelly.

The result was that scarcely any galls appeared on the tree that had been attacked for several years previously.

Another tree less affected was sprayed in February with Rex Brand lime and sulphur wash, and later with paraffin jelly, and the result was nearly as good.

RASPBERRY.

The Minute Rhynchites (*Rhynchites minutus* Herbst.)

A considerable amount of damage seems to have been done by the small weevil (*Rhynchites minutus*) to raspberries at Topsham in Devonshire. Mr. George Pyne, of Denver Nurseries wrote previously regarding an unknown disease in his raspberries, but as no insects could be found an opinion as to the cause could not be given. In June, 1911, however, more damaged material and beetles were sent, these proved to be a small weevil known as *Rhynchites minutus.*

The first indication of the disease is a ring of minute dots generally about two inches from the tip of the cane ; the portion above the dots then droops and withers, and the buds below which should remain dormant until next season then push out and form a branching instead of a straight cane.

The only other attack on cultivated fruit I know of is that recorded in the Board of Agriculture Journal for 1908*, where this beetle is mentioned as severely damaging strawberry plants at Grays.

This beetle which I figured in my work on Fruit Pests† is widely distributed over Britain, and according to Canon Fowler, is found on trees, especially young oaks.

* Vol. XV., No. 4., p. 275. July, 1908.

† "The Insect and Allied Pests of Orchard, Bush and Hothouse Fruits," p. 464, 1909.

The attack on raspberries appears to be very marked, and it is hoped that further details will be forthcoming this season.

The only treatment seems to be shaking the beetles off on to tarred boards or hand collection of the cut off tips, where the eggs are presumably laid as in the Apple Twig Cutter.

It is strange that we get two weevils, the *Anthonomus rubi*, and this, attacking both strawberries and raspberries.

Raspberry Weevil (*Otiorhynchus picipes* Curtis).

This weevil was reported as doing damage at Southfleet, Gravesend, in May. No mention was made as to the plants attacked, but as they came from a fruit grower it is supposed fruit trees.

It was also recorded as eating the shoots of plum trees in Devon, and also attacking some garden wall fruit.

STRAWBERRIES.

The Strawberry Button Moth (*Tortrix* (*Peronea*) *comariana* Zeller).

On May 17th Messrs. G. Mount & Sons sent some strawberry blossoms and leaves affected with maggots, stating that it was the first year that they had been noticed and that a field of about fifteen acres was affected, and in some parts they were afraid the whole crop would be spoilt.

This is the first occasion I have seen this moth which was recorded by Miss Ormerod as doing damage in the neighbourhood of Dee Banks, Chester. I know of no other record until Mr. G. Mount wrote me concerning this attack.

The material was kept, and the moths hatched out, and proved most variable in colour and markings. One would not expect any insect to vary to such an extent coming at the same time and from the same place.

The larvæ sent were nearly full grown, and this agrees with the previous record.*

The full grown larva (Plate XVIII. C.) is one-third of an inch long. The head is pallid, with two dark spots behind

* *Vide* "Insect and Allied Pests of Orchard, Bush and Hothouse Fruits," p. 453. F. V. Theobald.

when expanded. The body very pale greyish-brown, with a dark, dorsal line, and brownish sub-dorsal lines, each segment with four pale spots, which appear darker in certain lights; the first segment is dark in the middle and large. The legs all pale. The hairs on the body are pale.

The full grown larva had in some cases a greenish tinge.

In the younger stages the general colour was greenish, with darker dorsal line, and also the head and first segment, both of which were shiny.

A few were shiny, pale ochreous in colour with shiny black head and first segment and legs. The larvæ seemed to vary as much as the adults.

They commenced to pupate on May 23rd, and continued until June 2nd. Pupation took place in the spun up leaves and blossoms which they had destroyed. The pupa figured here (Plate XVIII. B.) is brown, with a slight silken cocoon, but when fresh is pale, brownish green with darker, almost red brown wing cases. The moths (Plate XVIII. A.) commenced to hatch on June 7th, and continued to hatch out until July 3rd. They soon laid eggs and caterpillars were found again in July and August, a second brood of the moths appeared in September, the first on the 4th. These I failed to get to oviposit and they have died. It is supposed that the adults hibernate. I have found them as late as October 7th at Buxton in a worn condition.

The larvæ seem to feed freely on the leaves at first, then they spin them up and get into the blossom. (Plate XIX.) The time to attack them seems to be when in the second brood of larvæ by either cutting off the leaves or heavy spraying with arsenate of lead.

The Strawberry or Black Anthonomus (*Anthonomus rubi* Herbst).

This beetle was reported doing damage to strawberries at Sandway, Maidstone, in May. Great numbers were found attached to the blossoms.

Together with *A. rubi* were a great number of small beetles known as *Anthobium torquatum*, Marsh, which is common on flowers generally, and not in any way restricted to the blossom of strawberries.

The *Anthonomus* was also reported, in May, attacking strawberries at Borough Green, by Mr. King Smith. None were found in my garden in 1911, where hundreds were caught by jarring the raspberries in 1910. It first appeared in 1906 on Strawberries. This small weevil also attacks the raspberry, but its effects are not so noticeable as on strawberries. It is also found on the rose and on bramble.

It has been recorded as harmful to strawberries at Penn, in Buckinghamshire, and in Herefordshire* as well as at Wye and the present record.

The attack on strawberries comes mainly from raspberries and brambles in the hedgerows. A few may be found by beating or sweeping in any large raspberry plantation. As it at present cannot be dealt with on strawberries it is important to keep it down on raspberries as far as possible, and this can only be done by jarring.

The Vine Weevil (*Otiorhynchus sulcatus* Fabr.).

The Vine Weevil (*Otiorhynchus sulcatus*) was sent by Mr. Lawrence, of Botley, Hants, where it had been attacking strawberry roots in its larval stage, and information was sought concerning it.

Numbers of the larvæ were sent me on May 25th, and these soon pupated and hatched out on July 20th.

The complete life history of this beetle does not seem to be known. I have recently found many of the beetles in the crops of some chaffinches and starlings examined early in February when the weevil larvæ are supposed to be living.

Cauliflower Disease in Strawberries (*Aphelenchus fragariae* Ritz. Bos.).

This disease, which is by no means common, was reported from near Sevenoaks on May 23rd. The disease was supposed to have been produced by artificial manures, which is quite impossible.

It is due to an eelworm technically known as *Aphelenchus fragariae* Ritz. Bos. The appearance of the plant at once gives us a clue to the disease, the flower heads especially becoming bunched and deformed, and the stem becomes

* "Insect and Allied Pests of Fruit," p. 461, Theobald, 1909.

thickened. It quite ruins the attacked plants, and these should be at once grubbed and burnt, and the hole filled in with vaporite or hot lime.

An account and figures of this pest may be found in my book on Fruit Pests.

VINES.

Woodlice (*Armadillidium vulgare* Lat. and *Porcellio scaber* Lat.) in Vineries.

Woodlice are frequently very annoying under glass, and may do a considerable amount of harm to soft fruits such as peaches and also to seedling plants. They are extremely difficult to eradicate. An inquiry how to do so was received from the vineries, Effingham, in March, from Mr. James Almond. These crustacea occurred in six large houses chiefly grapes, but they did not actually attack the grapes. They were present in the soil in the borders in vast quantities.

Some doubt has been cast upon the statement that wood-lice are harmful. The general opinion of nurserymen and market gardeners is that they are very harmful, and there is not the least doubt that those whose vocation calls them to be constantly noticing such matters are right. Because a naturalist finds many woodlice whilst collecting specimens to name amongst moss and rotten wood where they do no harm, it does not follow that such creatures do not do very serious damage under different circumstances and in different places where they do not think to look for their specimens.

An account of the British Woodlice has been ably prepared by Mr. Wilfred Webb, F.L.S., and many useful notes on their bionomics will be found in this book as well as excellent plates enabling one to identify them. Most woodlice live in very moist surroundings, they feed mainly at night, and undoubtedly attack seedlings of all kinds; many gnaw the roots of tomatoes and cucumbers, attack mushrooms in frames, and are recorded as eating the pseudo-bulbs of orchids.

The woodlice live all the year round, and are as active in glass houses in winter as in summer, as long as they have moisture.

They mostly reproduce in summer. The eggs are retained in a brood pouch attached to the female and there they undergo development.

The young or larval stages are passed within the egg. They constantly moult their skin when hatched and unlike an insect they keep on growing after they are sexually mature. The brood pouch referred to where the ova are carried is formed by plates which arise on the second to fifth thoracic segments on the lower surface between the legs.

These land crustacea breathe by means of gills which enable them to take up oxygen from moist air, but in some such as *Porcellio* oxygen is taken up by means of trachea or air tubes much after the manner of an insect.

Large numbers may be caught by trapping with hollow turnips, small pots of moss or hollow orange skins. Vaporite worked in the soil will also kill great numbers. Voss' Phospho-Nicotyl is the best remedy.

Besides the remedies already mentioned, I have found they may be killed by such poisoned baits as cut potatoes soaked in white arsenic.

Fumigation with hydrocyanic acid gas under glass also kills them, but one must have the houses fairly dry before this gas does its work.

TANGLEFOOT FOR BANDING.

A very large number of enquiries have been received regarding this preparation as a means of catching Winter Moths, Leaf Weevils, Apple Blossom Weevils and other fruit pests such as the Green Pug Moth caterpillar.

In all cases reported the preparation has been well spoken of, and to quote one grower alone in this respect is sufficient. Mr. Ivo Neame, of Macknade, Faversham, says in a letter regarding "banding": "I have found it so successful that I advise all others to sell and buy Tanglefoot."

Mr. Robert Amos, of Perry Court, Boughton, has found it far and away the best preparation he has used. The experiments I have continued with it in 1911, a remarkably hot year, showed that it did not run even under the almost tropical heat we were subjected to.

A series of experiments (now finished) with it to see the effect of placing it direct on the bark of trees may be thus summarised.

Apple Trees.

Banded direct in 1909, 1910 and 1911.

A. Old trees no damage at all.

B. Espaliers planted in 1909, no damage whatever.

C. Two maidens banded 1910, no damage whatever.

Pear Trees.

A. Two old trees banded 1909, 1910, 1911, no damage.

B. Four young espaliers banded in 1910 and 1911, show no sign of harm.

Cherry Trees.

A. Six four-year-old trees banded in 1909, 1910 and 1911, all as sound as two left unbanded.

Nuts.

Some thirty bands put on old cobs and filberts in 1909, 1910 and 1911. These were growing alongside of a thick ash plantation cut down in the winter of 1910. Last year every banded branch showed deep cracks above and below the banding.

Some ten young cob and filberts did not show any damage. It is possible that owing to the cutting down of the ash plantation the light so let in was the cause of renewed and rapid sap flow which the banded trees could not stand, and thus the splitting which is all on the side of the trees where the plantation was cut down may account for this phenomenon.

Plum Trees.

Only old plum trees were banded in 1909 to 1911. No damage whatever has resulted.

In America, however, it is said that Tanglefoot cannot be used direct on the wood of the peach and may do some harm to the pear.

In spite of its cost it will prove cheaper in the long run than the less costly greases, none of which last any length of time and have often to be applied from three to five times a year to do any good.

One point, however, with Tanglefoot must be mentioned that was pointed out to me by Mr. Martin, of Toddington.

He has found it answers all that was said of it, but that it attracts rabbits to such an extent that they have done endless damage to the trees.

Tanglefoot is supposed to be poisonous to animals so that this damage may be compensated for. But it is a point worth considering where rabbits are a pest, for they avoid ordinary *grease* banded trees.

OTHER FRUIT PESTS.

Amongst other Fruit Pests reported on are the following :—

Mussel Scale (*Lepidosaphaes ulmi* Linn.), from Yalding, and Smarden.

Apple Sawfly (*Hoplocampa testudinea* Klug). A large number of enquiries were received in 1911 from Kent, Surrey, Sussex, Norfolk, Devon and Worcestershire. One grower at Crockenhill reported 75 per cent. of his crop ruined by them. From Rye and East Peckham it was said that spraying had had no effect, nothing but hand picking is of any avail.

Raspberry Aphis (*Amphorophora rubi* Kalt.) from Barming, distorting the shoots.

Pear Leaf Blister Mite (*Eriophyes pyri* Nalepa) from Rickmansworth and Market Drayton.

Big Bud in Currants (*Eriophyes ribis* Nalepa) from Brentwood, Worstead, Norwich, Godnestone, Limpsfield in Surrey, Westerhill in Kent, Halesworth in Suffolk, Ramsgate, Guildford.

Aphides on Plum (*Aphis mahaleb* Koch.) from Suckley, Worcester.

Plum Aphis (*Aphis pruni* Reaum) was also reported as follows by Mr. W. Bear, of Magham Down, Hailsham :—" Not one to be seen on April 2nd. On April 11th they were swarming on the compact little knobs of Gisborne blossom buds. These were so compact that the pests had no shelter generally, and a clean sweep was made of them by spraying. A few also occur on the Czars."

Aphides on Peach (*Rhopalosiphum dianthi* Sch.) This was reported in May from Worksop, where it was attacking out-

door peaches. It was also found at Wye in February by Mr. A. Duffield on Daphne.

Woolly Aphis (*Schizoneura lanigera* Hauss). Several enquiries received from Sittingbourne, Bramley, Faversham, Kenley and Exeter.

The Stag Beetle (*Lucanus cervus* Linn.)

Larvæ of this beetle were sent from Newington, Sittingbourne on 18th of November, which were found on the roots of a young cherry tree, which had been grubbed owing to its failure.

Winter Moth (*Cheimatobia brumata* Linn.)

Specimens of larvæ were sent on May 19th by Mr. Cooper, of Shanklin, Isle of Wight, where they were still present in small numbers attacking apples, also from Chobham, Surrey, on May 10th from both apple and plums.

Eelworm (*Tylenchus sp* ?) in Strawberries.

From Ashdon, Essex, information was sought concerning the dying off of strawberry plants.

The eelworm which appeared to be the common *Tylenchus devastatrix* showed a marked preference for the Royal Sovereign and a small lot of George Monro.

Paxtons were found to be immune, whilst a strong growing Royal Sovereign found amongst them failed entirely under the eelworm attack.

The grower, Mr. R. L. Carlton stated that he was going to treat an acre or so with disulphide of carbon in autumn or winter, not only for eelworm.

Sulphide of potash, which undoubtedly has a deterrent effect on eelworm, has such a depressing effect on strawberries that it seems it cannot be advised.

ANIMALS INJURIOUS TO CORN.

The Corn Stem Moth (*Apamea oculea* Linn.)

Larvæ of this moth (also called *Apamea didyma* Esp.) were found to be in abundance attacking wheat at Puttenham at the end of April, 1911. Curtis* was the first to record this common insect as a wheat pest. He records the working as follows :—" The habit of this caterpillar is to crawl up a fresh stem of wheat about four inches from the ground and stop at the apex of the sheath, at which point it is expanded into the blade, where it commences gnawing a hole in the main stem, with its head downwards ; and in the course of a few hours it thus completely buries itself in the tube of the stem, having eaten the main stem quite through, it usually falls out of the sheath ; where therefore these fallen pieces are seen on the ground, they readily lead to a discovery of the caterpillar. It will continue thus within the sheath secure from observation, gnawing the tender stalk regularly round within, until it has consumed every portion of it quite down to the root, leaving the sheath partly occupied with its fæces. When the caterpillar has destroyed one stem, it crawls out to attack a fresh one in a similar manner."

Carpenter* publishes an account of it attacking barley and oats in Ireland at Glasnevin and Bray, County Wicklow, in just the same way.

In 1906† I mentioned this species as attacking cocksfoot grass at the Experimental Farm, Rothamsted, and killing it outright, as reported by Mr. A. D. Hall. Carpenter also found that those he had from barley and oats would attack cocksfoot quite readily when offered them, working down to the base of the shoot just as he found them doing in the corn.

* " Injurious Insects and other animals," 1907, p. 567.

† Report Economic Zoology for year ending April 1st, 1906, p. 71, 1906.

In those sent me from Rothamsted I also found some buried between the leaves, and a few even working under ground.

The outer leaves of the plants of wheat and grass turn brown or rusty colour, and then the whole plant dies right back.

Wheat plants I found did not flag at once, and several under observation did not die until some days after the larvæ had left them. The larvæ I noticed in all cases left the plant by wriggling backwards. The photo reproduced here shows one in the act of escaping from a damaged plant. (Plate XX. A.)

Life-history and Habits.

The moth (Plate XX. B.) which is extremely common all over Britain belongs to the Night Flyers or *Noctuidae.* It appears at the end of June and in July and August, and I have taken a few at sugar as late as September the 12th. In size it is nearly an inch in wing expanse, the front wings vary from drab to greyish or reddish-brown to almost black, in all there is a pale spot on the fore wings as seen in the photograph, varying from pure white to dusky yellow. Some specimens show a dark central band on the forewings ; the hind wings are dark brown, paler towards the base.

It is found also flying by twilight and it is attracted both by light and sugar. Some hundreds were caught one night around a lamp set in a tray of oil to see what injurious insects may be caught by light traps in my garden in August, 1906.

The eggs are now known to be laid on grasses and corn in July and August, and hatch in August, September, October.

The caterpillar varies in colour almost as much as the moth does. Those I have seen are mostly dull greyish-green, some bright green, all have a line on each side of the back, and a dull reddish side line, and the spiracles may be darker than the rest of the body, sometimes quite black. When mature they attain the length of about three-fourths of an inch. The head is pale to dusky brown, and there is a darker tail shield.

Specimens from Rothamsted pupated on April 29th,

and on until June 4th. Those from the Puttenham wheat nearly all between May 14th and June 7th. Carpenter's larvæ pupated later than any of mine—June 18th.

The larva pupated in the soil. The pupa is brown, and those I kept were free in the soil. Curtis says the larvæ "form a substantial cell about one inch below the surface," mine were found from two to two-and-a-half inches deep in the sand of the breeding cage.

The pupal stage lasts from five to seven weeks.

That they do considerable damage to grass is quite likely, damage that escapes detection. That they do so to corn we also know.

Carpenter thinks that there was no doubt that in the two cases he records that the larvæ made their way to the cereals from grasses. This is probably usually the case.

His suggestion of ploughing or digging up the grassy headlands around cornfields is the only thing likely to prevent further damage.

The Gout Fly (*Chlorops taeniopus* Meigen).

The so-called Gout Fly of Barley, sometimes spoken of as the Ribbon Footed Corn Fly, the *Chlorops taeniopus* of Meigen has been so frequently referred to by economic entomologists that it may, at first, seem unnecessary to write anything more. But I do so on account of several new facts having come to light, and also to record the very marked feature seen in an attack of this pest during the past year in Surrey, which so far has not been recorded, if observed. The disease it produces is spoken of as Gout or Poddle, and the fly is also called the Haulm Fly or Yellow Haulm Fly.

The Gout Fly belongs to a family of flies called Chloropidæ, and to the genus *Chlorops* of Meigen. Verrall* records eleven species of this genus in Britain and I fancy there are several more yet to be recorded.

Although I have only bred one species from barley, namely *C. taeniopus* Meigen, and the same last year from wheat, I have received larvæ from Wales,† which were evidently of a different species.

* List of British Diptera, 2nd ed., p. 35.

† Second report on Economic Zoology, British Museum, p. 23, 1904.

During a visit to Cranleigh, Surrey, to investigate a bad attack of Gout Fly I also found in one field a larva differing from the typical *taeniopus* in some small details, and in some numbers in one part of the field. Unfortunately I was going away, and the specimens were not sent on to me.

The attack of Gout Fly in barley and sometimes wheat and rye, is in some years quite serious on bad land, especially poor, chalky soils and around the edges of fields.

The attack of last year in Surrey at Cranleigh and in the neighbourhood generally was the worst I have seen, the entire crop being destroyed in several fields I visited.

In 1893 much damage was done to barley, it being recorded that many hundreds of acres were fed off with sheep as the plants were too damaged to be of any use. Miss Ormerod in her Reports for 1877, 1878, 1879, 1880, 1882, 1885, 1887, 1888, 1889, 1890, 1892, 1893, 1894 refers to this cereal enemy. It is widely spread over England, specimens and records of its attack having reached me from various places in Kent, Surrey, Sussex, Cambridgeshire, Essex, Hants, Yorkshire, Hertfordshire, Bedfordshire, Huntingdonshire, Gloucestershire, Somerset, Devon and Lancashire. I found it in abundance near Filey in 1889, in Surrey it was most harmful between 1880 and 1900 around Kingston-on-Thames, attacking rye and barley. I have also investigated fields badly attacked near Battle in 1890, and near St. Neots in 1892, and near Cambridge in 1887 and 1889, in these cases the crop was practically ruined as seen at Cranleigh last year.

The following are the places from which this pest has been recorded by various authors :

England.—Herne Bay, Kingsnorth, Dartford, Farnborough, Wye, Faversham, Deal, Westwell, Eastwell, Lydd, Tenterden, Orpington, Charing, Sevenoaks, Otford, Sheppey in Kent; Danehill, Sussex ; Holkham, Hilgay, Norfolk ; Akenham, Ipswich, Bury St. Edmunds, Suffolk ; Hinckley, Colworth, Woburn, Witstead, Amptill, Bedfordshire ; Woodhall, Rothamsted, Harpenden, Wendover, Tring, Bishop's Stortford, St. Albans, Hertfordshire ; Pleshey, Maldon, Chelmsford, Essex ; Downton, Wiltshire ; Kettering, Syston, Leicestershire ; Alford, Lincs. ; Littleport, Ely, Cambridge, Madingley, Cambridgeshire ; Crondal, Alresford, Winchester, Hamp-

shire; Broughton, near Aylesbury, Bucks; Packlington, Hessle, Hull, Goole, Yorkshire; West Gloucestershire; High Leigh, Cheshire; Ashby-de-la-Zouch; Masham; Fairfield; Massington, Wainsford.

Ormerod records it in 1841 from Lancashire, Bristol, Sarsden, Hayes, Huntingdonshire.

Scotland.—Girvan, North Berwick.

Wales.—Arthog, Dolgelly.

Ireland.—Dunmore, Durrow, Queen's County and Crossabeg, County Wexford.

The usual manner of attack is for the larvæ to tunnel from the ear or base of the ear, downwards to the first node in the young plant of barley, wheat or rye before the ear has escaped from the sheathing leaves, and to cause the whole plant to become stunted and much swollen as shown in the photograph. Sometimes dwarfed specimens only six inches high may be seen. In the majority of cases the ear never escapes from the sheathing leaves, and consequently the crop is lost. This swollen, gouty appearance is characteristic in very bad cases. Now and then if the land is in good heart and rain comes at the right time the ear may get free from the sheathing leaves and develop, but in this case the cobs on one side are absent or reduced and never a good sample.

In the fields visited in the Cranleigh district, in 1911, the loss was complete, the whole plant right through the fields had been unable to escape the sheathing leaves. Owing probably to some shower during the hot, dry summer, so favourable to the fly, so harmful to the barley, the plants had tried to produce their kind by throwing out a new growth. This is shown plainly in the photograph, a typical specimen of all plants I examined in several fields. (Plate XXI.)

This thin, spindly, lateral new growth had at most a dozen weak cobs, in nearly all only two or three fully formed and in many none whatever. In any case this attempt to save itself was of no value to the farmer, and at once I advised to feed off with sheep or burn the crop as it stood, as the straw was practically nil.

Life-history of the Gout Fly.

The adult fly is about one-sixth of an inch long, black and pale yellow in colour, the yellow head has a black triangular

mark on it ; the thorax is yellow with three broad dark lines ; the abdomen is yellow with dark greenish-brown transverse bars. The legs have yellow femora and tibiæ, the latter tipped with black, the fore feet of the female are black, in the male the basal and two terminal tarsals only are black ; mid and hind feet of male and female have the three basal segments yellow, the last two dark. The wings are transparent. The first brood of flies appear in late May and June, and are found flying about amongst grasses and corn and rank herbage, from which they may be obtained by sweeping.

The females deposit their eggs on the outer leaves of the corn plants before the ear has escaped from the sheathing leaves. The eggs are elongated, white in colour, with hexagonal sculpturing on the upper surface, and a longitudinal groove below. They may be laid singly or in pairs.

The larvæ live in the straw, first of all attacking the base of the ear and often destroy the grain on one side, then they tunnel downwards to the first node, leaving behind a blackened tunnel or open groove. This working prevents the ear from bursting from the sheath, stunts the growth and the plant assumes the deformed appearance shown in the photograph.

The maggot is shiny yellowish-white, and when mature reaches about one-fourth of an inch in length.

By the end of June they commence to pupate, but I have found a few larvae as late as August 5th, most, however, have changed by mid July.

The pupa is formed in a puparium of a brown colour, some being pale yellowish brown, and rather flattened in form, about one-fifth of an inch long.

This stage takes place inside the tunnels as a rule, but in some sent me from Arthog, near Dolgelly, North Wales, by Professor Percival, pupation had taken place between the damaged ear and the sheathing leaf.

The pupal stage lasts from two to four weeks. The second brood of flies appears in August, September and October. The earliest date of hatching I know of is August 12th, and the latest October 2nd. I have kept some of these autumn brood alive for two weeks, and found they readily oviposited on couch, timothy and meadow foxtail grass. It appears that they will also lay their eggs on rye and any

autumn sown corn that may be up. The eggs give rise to larvæ which pass the winter in the wild grasses or corn, especially at the top of the undeveloped shoot, and appear to grow but little. These pupate in spring, and give rise to the first brood in May and June.

In the Board of Agriculture Leaflet, No. 24, 1903, it is stated that there are two or more broods during the year, but I have failed to trace more than two, and can find no other record.

Preventive Measures.

This attack usually manifests itself in an epidemic form under three conditions : (1) on land in bad heart ; (2) in a very warm, dry season, and (3) in late sown barley.

The first can be remedied and then it will be found that the second causative agent is not so serious.

The important thing in " gout " districts is to sow as late as possible the winter corn, and as early as possible the spring corn, so as to avoid the second brood, and to have the plant so forward when spring sown that the proper stage for egg-laying has passed.

There is no doubt that the disease very often comes from wild grasses. It is well, therefore, to see that the headlands are deeply covered in and that the grasses along hedgerows, ditches, etc., are cut and burnt in the winter.

I have never found any puparia in machine refuse, but Carpenter thinks it probable that many puparia occur there, and thus it is advisable to destroy all refuse after threshing. If not for this reason it certainly is to destroy the countless red puparia of the Barley Midges (*Diplosis equestris*, etc.).

Parasites.

Curtis records two parasitic hymenoptera attacking Chlorops, one *Caelinius niger* N. a. Essenback and a small Chalcid, *Pteromalus micans* Olivier.

I have never been fortunate enough to breed any parasites from those I have kept.

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The Wheat Bulb Fly (*Hylemyia coarctata* Fl.)

This wheat insect which is by no means widely spread as a pest, although single specimens may be taken here and there all over the country, was reported in April, 1911, as doing considerable damage to autumn sown wheat at the Priory Farm, Puttenham. Specimens were also received from near Lincoln and from Romney Marsh, and a few larvæ were also found in some damaged wheat plants sent by Dr. Goodwin, from Nottinghamshire. The Wheat Bulb Fly (*Hylemyia coarctata*) is chiefly harmful in the fens, where according to Ormerod it is most destructive on land fallowed in the previous summer and also where a crop has been so thin that much land is exposed. It has also been noticed that it is bad on land dressed with pond and dyke mud, but it is difficult to see how this can affect it.

The damage is done by the maggots eating their way into the young plants and destroying the centre, often completely eating out the growing point, from which, however, the plant may recover by tillering out. The grubs lie lengthways in the plant. They might when small be mistaken for Frit Fly larvæ, which I have this last season also found in wheat, but can at once be told by the absence of branched external spiracles at the head end and by the peculiar structure of the tail end.

The attacked plants present no special peculiarities, they merely flag and die and turn brown, much as in wire worm attack.

The attack is most noticeable in April because at that time the damage is most serious owing to the ravenous nature of the grubs as they near maturity. By April they are about one-fourth of an inch long.

Carpenter records seven acres of wheat destroyed by it in County Dublin in 1901. The wheat was sown in January on land previously cropped with potatoes. This has several times been noticed, but where wheat follows turnips, mangolds or beans it does not seem to occur, yet it does after swedes.

Collinge* records it from Long Melford, Suffolk.

The life history is briefly as follows. The adult flies (Plate XXII. C.) which belong to the family called *Anthomyidae*

* Journal Cooper Research Laboratory, No. 1., p. 65, 1909.

appear in June and July. In general appearance they are somewhat like a house-fly about one-fourth of an inch long, grey, the thorax with indistinct lines, the abdomen narrow and grey; the legs grey, paler basally and the whole insect hairy, the wing veins are yellowish-grey; in the female the thoracic markings seem to be absent. The summer flies lay their eggs as far as I know on such grasses as couch and meadow foxtail, at least I have found the larvae there when they pupated in September, and hatched into a second brood of flies early in October. These unfortunately died, so I am unable to say if they hibernate or lay their eggs on grasses and early sown corn. I imagine, however, that they must hibernate or we should not have spring sown wheat attacked as recorded by Carpenter. In any case there are two broods, and it is quite possible that some puparia hatch out and lay eggs on the young autumn sown corn, and others remain as puparia until the spring, as is the case with the Onion Fly.

Ormerod records larvæ as early as February, and thus it is probable that there are late autumn hatched ones.

The maggot is white, in some the intestinal tract was plainly visible as a dark median line, it reaches when mature about one-fourth of an inch long, when extended it tapers to a point at the head end which has two curved hooked mandibles; at the tail end it is roughly truncate, the caudal segment ending in two large median bifid papillæ and a large papilla on each side.

Carpenter in his original figure (Fig. 3, p. 200) shows a smaller papilla basally on each side in addition. I could not see this in the specimens I examined alive. There are two terminal median spiracles and on the base of the first segment two short external spiracular processes. The larvæ under observation all pupated in the plants, but other recorders show that they may also pupate in the soil. The pupation takes place in the old skin of the maggot, which forms a deep brown puparium. Those sent from Puttenham lasted four weeks in the puparium stage, the first fly hatching on June 25th, the last on July 5th.

Barley and oats do not so far appear to be attacked.

Judging from what we know of this insect trouble, it

appears that its presence may be kept up through couch and other wild grasses, and possibly also cultivated grasses.

All that seems possible to do is to give an attacked crop a good dressing of nitrate of soda, so as to hasten growth and then many of the less damaged plants will tiller out and so a decent plant may be obtained.

Also in areas where it is abundant, extra thick sowing of seed is advisable as a certain amount is sure to escape, and so a crop obtained.

Where a crop is so badly damaged that it is valueless, it is best to drag up the plants, harrow them together and burn them. Deep ploughing may do some good, but unless the plants are thoroughly buried the flies will escape, for the larvæ I find will go on developing if the plants are turned upside down and buried in six inches of soil.

The Frit Fly (*Oscinis frit* Curtis).

This dipteron is now reported annually, but it did not seem to be quite as harmful as usual in 1911.

It was found by Mr. C. E. Bass, of Tourney Hall, Lydd, however, who sent plants on the 5th of June badly infested.

A previous attack of this fly and eelworm had been so bad that it was found necessary to plough the oats up and plant roots.

The specimens sent came from a field in which the seed had germinated well, and promised a good crop, but there was then a large percentage dying off as the sample sent. Mr. Bass mentioned that some of his neighbours' fields were in the same condition.

All that can be done to check the often total loss caused by this maggot is as far as possible to cultivate winter instead of spring oats, for the former never suffer to the same disastrous extent as the latter.

Corn Aphides.

An inquiry for information concerning Corn Aphides in general was received from the Rt. Hon. Lord Delamere, considerable damage being done to his wheat in East Africa by an aphis.

It appears to be the so-called Southern Grain Louse (*Toxoptera graminis* Rondani) which occurs in Europe and

in America, but which has so far not been recorded in this country.

Specimens of the aphides are being despatched from Africa.

The following précis of Corn Aphides was sent.

Seven Corn Aphides are well known, but as yet very little has been found out in regard to their life cycles.

What becomes of one British Corn Louse and the Durra Aphis of Africa when not on the corn is at present an enigma. Oviparous broods are unknown. One European Corn Aphis (*Siphocoryne avenae*) we know lives on apple and pear as a second host.

In all probability the American Corn Aphis (*Aphis maidis*) is the same as the Corn Root Louse (*Aphis maidis-radicis*) the one attacking the leaves, the other the roots.

The Spring Grain Louse (*Toxoptera graminis*) probably oviposits on wild grasses and self sown corn.

In all countries Aphides are much subject to hymenopterous parasites, but in spite of these, great damage is too frequently done by these Plant Lice. Where root forms are present treatment with vaporite will exterminate them, and frequent moving of the soil will be prejudicial to their increase.

Rotation of crops is also very essential and the burning of wild grasses around the cultivated areas is sure to lessen the amount of Aphis. Blowing tobacco dust over Aphis has proved beneficial in this country, but opposite results seem to have been obtained in the United States.

The enormous rate at which the Aphides can increase under certain favourable climatic conditions is one of their most important features, and this reproduction is asexual. As a rule at the end of the year an egg laying generation is formed. In a large number of cases the oviparous brood is unknown. In fact but little is known concerning these creatures.

1.—The Spring or Southern Grain Louse or Green Bug (*Toxoptera graminis* Rond.)

Occurs in Southern Europe and Hungary, and is supposed to have been introduced into North America.

Will breed freely in temperatures between 100 degrees to

below 46 degrees F. Young mature in eight days, and can then produce living young. Is said to be effectually held in check in normal years by its natural enemies.

Essentially a leaf insect, rarely found on the stem.

Attacks oats most, then rye, wheat, barley and is often found on under side of lower leaves.

Corn excepted, its effects on the leaves of grain is to cause them to change a red colour—this is characteristic of *Toxoptera*. Also feeds on various wild grasses, and probably they constitute the alternating food plant.

Tobacco dust had no effect. Kerosene emulsion destroyed them. Whale oil soaps cleared them out, and protected the plant. Webster says : " With all the artificial introductions of this parasite that were made there is no probability that a single bushel of grain was saved thereby."

Rolling if the land is fairly level is useful.

Lime and Sulphur ineffective. Appears to originate in spots. These may be ploughed in or burnt.

Lastly Webster says this : " If the farmers instead of being carried away by the highly coloured newspaper reports of the effect of the introduction of a few parasites in their fields, will seek to evade the pest by the destruction of volunteer grain in the fall and late sowing in the extreme south, and turn their attention to better farm methods not only cultural but by means of rotation, watching for and stamping out the pest when it first appears in the fall and winter, they will suffer far less from the destruction of their crops when the next invasion occurs." 1909.*

2.—The Corn Leaf and Root Aphis (*Aphis maidis-radicis* Forbes).

The leaf aphis does little direct injury. The root aphis does—sucking the sap of the roots it dwarfs the plants, the leaves turn brown and die. Fields become " spotted," some areas making little growth.

Leaf Aphis (*A. maidis* Fitch) occurs in America, South Australia and Japan. Colour, bluish-green. Appears at the time the root aphis decreases. Not known whence winged

* Circular 93 revised. Bur. Ent. U.S.A. Dep. Agric.

females come from in July. Supposed to occur elsewhere than on corn.

Corn Root Aphis (*Aphis maidis-radicis* Forbes). Colour, bluish-green, with white waxy bloom. Winged female has black head and dark thorax, abdomen pale green—three marginal black spots.

The male is wingless and found on the roots. Eggs are found in the fall in the runs of and attended by ants. When they hatch the ants carry the young to the roots of Foxtail grass, etc. and when the corn is up they take them to the corn, also to grass roots and weed roots. These breed in spring and summer on the roots of the corn.

As long as the roots give food all are wingless—when this ceases winged females come and are found on the leaves. The ants will carry these back to the roots and there they produce living young on the roots just as they do on the leaves.

Crop rotation.—When there is a constant rotation this insect does not do much harm—only where corn is grown year after year on the same land. Where rotation cannot be carried out constant stirring of the soil is advised.

The other method recommended for the Southern States is late or fall ploughing.

It is also observed that where farmyard manure is used that destruction is not so great.

Treating seed corn with oil of lemon and alcohol as follows: 1 gallon wood alcohol, 1 pint of oil of lemon, use 6 tablespoonsfull to each gallon of corn and well stir in. The odour lasts for weeks underground, and it is inexpensive.*

3.—European Grain Louse (*Siphocoryne avenae* Fab.).

This is the same as the Green Apple Aphis (*Aphis fitchii* Sand). Occurs in America and Europe on apple, pear, quince, etc., and on grain.

Eggs laid on the apple, etc., and remain there all the winter, hatch in spring and attack the leaves, blossoms and shoots and later fly to the corn and grasses, still later they return to the fruit. Green in colour, cornicles dark brown and short. On ears of wheat.

* Webster. Circular 86. Bur. Ent. Dep. Agric., U.S.A., 1907.

4.—The English Grain Louse (*Macrosiphum granaria* Buckton.)

Occurs in Britain and America. Yellowish-green; head yellow to brownish-yellow in wingless female. Winged migrant green, thorax with black lobes—cornicles black, abdomen with dark areas. On leaves and ears of barley and oats, *wheat* and rye and many grasses.

Life history unknown.

5.—German Grain Louse (*Macrosiphum cerealis,* Kalt.)

Very like 4, but the abdominal markings are absent, and the cornicles are shorter. Also found on Red Clover. Green to red brown, cornicles black. Winged female reddish-brown. Abdomen green with black sidespots.

6.—Clover Plant Louse (*Macrosiphum trifolii* Pergande).

On wheat, oats and red clover and on strawberries, dandelion, etc. Green with whitish meal in places, a median darker green line. Cornicles yellowish-black at apex.*

7.—The Dura Aphis (*Aphis sorghi* Theobald.)

This greenish Aphis is the common Dura and Millet Aphis of the Sudan, and the same occurs in the native territory of the Cape. It frequently completely destroys the crop. Crops when once badly attacked are burnt and replanted.

* Bull. 41. Div. Ent., U.S.A., Dep. Agric., 1904.

ANIMALS INJURIOUS TO ROOT CROPS.

Surface Larvæ.

Considerable damage was reported from the neighbourhood of Colchester by Mr. Harwood, caused by the larvæ called Surface Larvæ or Cutworms, to mangolds, brussels sprouts, celery, carrots and onions and some other plants.

The two commonest species, namely, the Heart and Dart Moth (*Agrotis exclamationis*) and the Turnip Moth (*A. segetis*), were very plentiful generally in 1911 and 1912, and did considerable harm also to corn.

Mr. Rice, of Eastry, wrote concerning this attack in September sending the larvæ of the Heart and Dart Moth, saying they had appeared in large quantities in market gardens in the neighbourhood.

These larvæ are easily got rid of by means of poisoned baits. Clover or lucerne should be first heavily sprayed with arsenate of lead, then cut when the poison has dried and small patches spread about on the soil of the infested field or garden.

Therevid Larvæ Attacking Turnips.

On September 9th, Mr. Harwood, of Colchester, sent some larvæ (fig. 4, A.) with the following note: "I have found the enclosed creatures at the roots of some white turnips which they appear to be killing at a rapid rate. They do not seem to attack the turnips themselves but only the fibrous roots. The farmer who drew my attention to them calls them wireworm." These larvæ had taken a very heavy toll of the white turnips, some of which were getting large, and writing later in September, Mr. Harwood said they were still busy with those that are left. The larvæ (Plate XXX. C.) are vermiform in shape, shiny white in colour and composed of as many

as twenty marked segments. They feed in the ground upon various roots, where they pupate.

The pupa (fig. 4, B.) is nearly cylindrical, bare with two little horn-like processes in front; it occurs in mould and has been recorded as being found under stones in sandy places.

The adult flies are found on the leaves and flowers of plants, on tree trunks and often settled on the ground. Their flight is sudden and swift, flying only short distances. The males sometimes dance together in the air. Judging from the number of these larvæ I have received, especially from fields and from pot plants, they must occasion no little loss.

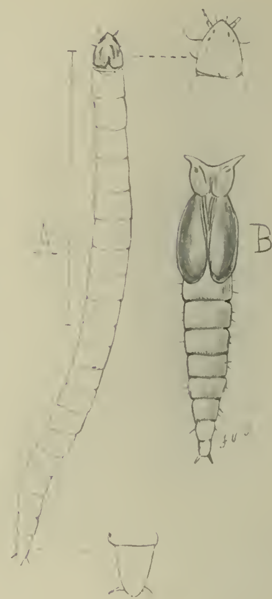

Fig. 4.

Larva (A.) and Pupa (B.) of *Thereva* sp. (magnified twice).

Turnip Seed Maggots.

A considerable amount of loss appears annually to take place on Romney Marsh from the attack of at least two maggots which affect the seed pods of turnips, swedes, mustard, rape and cabbage, but especially amongst turnips and swedes.

The major part of the damage is due to the Turnip Seed Weevil (*Ceutorhynchus assimilis* Payk) in some areas, and in others the major pest is the Turnip and Cabbage Gall Midge (*Cecidomyia brassicae* Winnertz). A third larger maggot was found in one or two cases, but it did not seem to be of any importance. It was a weevil larva which worked up the stem. At Eastbridge a number of plants in one field were found to be attacked in June by it. Mr. Morrison, who first brought my attention to this matter, informed me that it was no unusual thing for as much as thirty or forty per cent. of the seed crop to be destroyed by these insects.

I visited the district one day and saw several fields

attacked, some in which not more than ten per cent. of the pods were ruined, but in one or two I think Mr. Morrisons' estimate of the damage was too low, for as many as sixty per cent. of the pods I counted were galled and ruined by these two pests. Although only a small part of the infested area was examined and that only hurriedly, I should say, on the whole, the Midge larvæ were doing the most harm. I hope to follow up this subject, which seems a very important one this year.

A few notes on these two insects are here appended :

1.—The Turnip Seed Midge or Gall Fly (*Cecidomyia brassicae* Wtz).

This is a small fly belonging to the same family as the Pear Midge and Hessian Fly, several of which are very destructive. The adult is about one-tenth of an inch long, with two transparent wings, black with reddish abdomen with dark bands, the wings are limpid with dark veins and the balancers or halteres are rose-coloured at their base in fresh specimens ; the legs are dusky with pale, almost silvery hairs ; the female has a pale ovipositor, which, like the Pear Midge, is capable of being extended. The flies appear in May and June, and this probably accounts for finding the small maggots of various sizes, or two broods may possibly overlap.

The female by means of her extensile ovipositor lays her eggs in the young and older pods. These turn into small white footless larvæ, often almost pure white, which measure one twelfth of an inch long. I counted in some pods as many as thirty-five. Ritzema Bos* records up to as many as fifty in a single pod, and Walker† up to sixty in a single pod. These larvæ, which are more or less straight in form, can be easily told as belonging to this species by having a small brown process beneath, the anchor process of the shape figured. (Fig. 5, A.) They eat the unripe seeds and cause them to shrivel up. The attacked pods are very marked (*vide* Plate XXII. A.), for they swell up abnormally and ripen in colour prematurely, then when the maggots are mature they burst, and the maggots fall to the ground. Quite young pods were found to be attacked in this manner.

* Tiersiche Schädlinge und Nützluige, p. 588.

† Insecta. Brit. Diptera. III., p. 84.

The maggots on falling to the ground enter the soil and there change to the pupal stage. Many of them simply make their way under clods of earth to do this. In about two weeks the pupæ hatch into another brood of midges, and these at once lay their eggs in other pods.

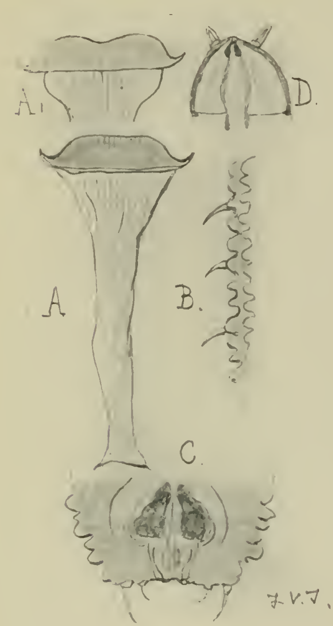

Fig. 5.
Larvæ of *Cecidomyia brassicae* Wtz.
A. Anchor Process; B. Skin; C. Anal Segment; D. Head. (Greatly enlarged).

Larvæ were found up to the first week in October.

Curtis, in his Farm Insects, does not mention this insect, but Ormerod* refers to an attack reported to her from Goundas in Aberdeenshire, her correspondent saying it was most common on the Yellow Turnip, but that he had found it also on the swede and on Scotch Kale. The pest was first noticed on July 7th, and unaffected seed was ripe about a fortnight later. The attack is quite different from the Weevil, the seed pods swelling, turning yellow and bursting.

As far as I could find out the winter is passed in the puparium stage in the soil. I saw one field particularly badly damaged at Eastfield by the Cecid and also the stem borer.

The larvæ are also recorded† as living in the flowers and leaves of the cabbage, but I fancy this is another species.

2. The Turnip Seed Weevil (*Ceutorhynchus assimilis* Payk).

The attacked pods due to the weevil can easily be told by having small round holes in them. They do not swell to the

* Rep. Inj. Ins. 20th, for 1896, p. 149 (1897).

† An Account of British Flies. Vol. I., p. 64, 1892. F. V. Theobald.

same extent. On opening them one finds inside a white curved larva with wrinkled skin, and slightly hairy, and with a prominent brown head. These larvæ feed right into the seeds even as they are ripening, they gnaw the tissue around, and then eat their way out, leaving behind a small round hole so characteristic of the attack. On reaching the soil they form a small earthen cocoon and pupate, and hatch out in August into small weevils about one-sixth of an inch long, of a black colour covered with grey and white hairs when fresh. There are at least two broods of this beetle during the year. The last brood hibernate, and in spring we find the beetles feeding on the flowering shoots of mustard, cabbage, turnip, rape and on charlock, and according to Curtis on wild mignonette. The pupal stage according to Curtis lasts three weeks.

A full account of these two insects it is hoped will appear with notes as to prevention in the next report.

Pigmy Mangold Beetle (*Atomaria linearis* Stephens.)

This beetle seems to be more general than formerly supposed. Several enquiries from widely different areas have been received.

On May 29th mangold plants were sent from Egham, Surrey, badly attacked by the *Atomaria*. The fields had been cropped with mangold and corn for years. A great deal of the plant was completely destroyed. An attack was observed near Wye on May 22nd, but although a fair number of the young plants died a good crop resulted.

So far I have had records of it from Godalming, Surrey as well as Egham; Much Marcle in Herefordshire; St. Neots in Huntingdonshire; Barnstaple and Ashburton in Devon; Lymington; Denham in Buckinghamshire; Shrifnal in Shropshire; Weston-super-Mare in Somersetshire; Wye and neighbourhood generally.

At present the only treatment found to do any good is heavy rolling to consolidate the seed-bed and top dressing with soot. (See Fig. 6, p. 172).

Beetles (*Steropus* (*Pterostichus*) *madidus* Fab.) on Mangolds.

This ground beetle was found to be seriously damaging mangolds at Bromley in June, 1911. It is well known as a

mangold pest. Besides feeding upon this plant it also attacks strawberries and swedes and kohlrabi.

Ormerod recorded it as attacking mangolds, having received specimens caught early in the morning in the act of devouring the plants.

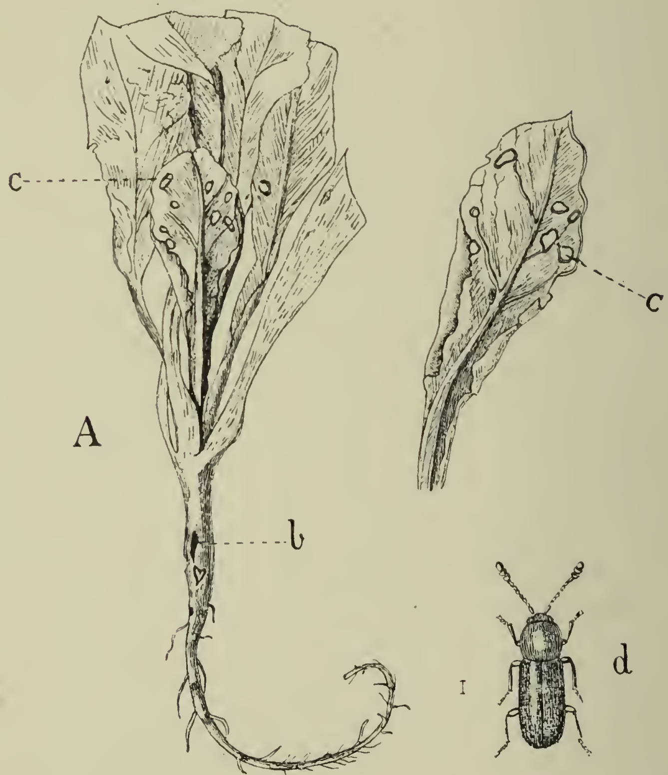

FIG. 6.

THE PIGMY MANGOLD BEETLE.

A. Mangold plant, showing damage done by *Atomaria linearis* to root (b), and leaf (c); d. Adult Beetle. (*From Second Report on Economic Zoology* (*British Museum*), F. V. Theobald.)

The beetles do not seem to touch the leaves, but devour the root at and just under ground level, sometimes gnawing the shoulders of the roots completely around. In some received holes only were eaten, others were eaten completely away. Those partially eaten, of course, never properly de-

velop. The beetles work almost entirely of a night and hide away during the day time in the earth and under stones. Curtis records this beetle as feeding upon wireworms.

In 1897 it was recorded from Ramsgate* the mangolds being eaten off at groundlevel, the beetles being found to feed only at night, and in the evening. Moving the soil has been found to do good.

Great numbers of the beetles may be caught by throwing down here and there a freshly flayed sheepskin, the fleece upwards; the beetles collect in daytime beneath and can then be crushed.

The Mangold Fly (*Pegomyia betae* Curtis).

This Mangold Fly has been present in some numbers during the past year. At Egham, Surrey, at the Manor Farm, it was very bad, and at the same time the Pigmy Mangold Beetle was present.

A very bad attack occurred at Wickham Farm, Pirbright, Woking. Several acres were very much damaged by late May and fear was expressed that the whole would be completely spoilt. The disease was also bad in the Guildford area, and several of the big Mangold growers complaining of the great harm done to their crops by the grub. In one case Messrs. Bowyer and Baker reported that a big acreage was almost entirely ruined. Another attack was reported by Mr. C. W. Higgs, of Orpington, on June 7th. A few days later Mr. Buley, of Woodnesborough, Eastry, sent specimens saying they were doing a lot of damage and were much more abundant than in the two previous years.

This root pest was referred to in the last report, pp. 88-90.

A photograph of the eggs taken by Mr. Blakey, of Redditch, is reproduced here. (Plate XXII. B.)

Mangold Aphides (*Aphis rumicis* Fabricius; *Aphis atriplicis* Linnæus; *Aphis* nov. sp. and *Rhopalosiphum* nov. sp.)

A vast amount of damage was done in 1911 by aphis attack on mangolds all over the south and south-east of England.

* Report on Economic Zoology for year ending April 1st, 1908, p 91., 1909. F. V. Theobald.

A very bad attack was reported from Bromley, and hundreds of acres were attacked in East Kent, especially along the sea board, but also inland in patches.

In consequence, the growth of the plants was much checked and considerable damage done.

The past year was, generally, one of the worst for aphis damage that has occurred for a long time. Owing to the prolonged heat and drought the plant growth was checked, and the conditions were most favourable to aphis development and reproduction. A considerable area in Kent was visited and aphides collected from the mangolds.

Not only did they attack mangolds in the fields, but in gardens beet suffered very severely. Comparatively few, however, attacked the Sugar Beet on the College Farm.

Four distinct species of aphides were found on the mangolds* namely: (1) *Aphis rumicis* Fabricius; (2) *Aphis atriplicis* Linnæus; and two new species which are being described in *The Board of Agriculture Journal.*

Buckton describes under the name of *Aphis atriplicis* Linnæus, a black aphis. This I cannot separate from the Bean Aphis (*Aphis rumicis* Fabricius).

By far the most destructive species was the Black Aphis (*A. rumicis*) which swarmed under the leaves in dense thick masses, causing them to curl and twist up in characteristic manner. I found this insect swarming in all the fields visited in East Kent, especially so at Herne Bay, and from there up to Faversham, it was also in vast numbers right across the county through Canterbury to Dover. Very similar attacks occurred in patches on Romney Marsh, and through the Ashford-Maidstone valley. This Aphis is also known as *Aphis papaveris.*

The commonest food plant of this aphis is the poppy. All varieties and species of poppies, wild and cultivated, are attacked by it. It swarmed on them in early June and went on increasing until the beginning of July, when the poppies mostly succumbed mainly owing to their attack. The poppies along the Thanet coast were found to be black with them.

* A second list of the Aphididae found in Kent. *Entomologist*, November, 1911. F. V. Theobald.

Some Shirley poppies sown on waste land round the College were also smothered and destroyed.

On June 4th I found the first winged females, and from then onwards they kept appearing, and in the first week of July great swarms of winged females occurred and left the poppies. These settled on all manner of plants, even the tops of onions and leeks were blackened with them. They occurred also on hops, settling in small round clusters under the leaves, varying in size from a threepenny bit up to half a crown. Where they were present on the hop leaves in these groups, they could be detected from above the leaves by the round pale patches they produced. A few of them produced young, but in a week they had all died off, evidently not finding the hop a suitable plant. The same occurred to the masses on the onions and leeks, but not until they had killed the tips. The dead, wingless females remained on the plants for some weeks.

They also occurred on fruit trees and bushes, on roses, on oak, lettuce and cabbage, but on none of these did they live.

Those which settled on mangolds, beet and various wild Chenopodaceæ at once commenced to produce living young, and continued to do so right through July and August. In 1899 a similar attack occurred in East Kent, and at the same time vast swarms of this black aphis appeared in winged form and settled on all manner of plants, including as last year onions, leeks and hops, but died off more rapidly, apparently at once being attacked by a mould fungus.

There was not so persistent an attack on the mangolds that year, as the weather was favourable to the growth of the plants and unfavourable to the dolphin.

I recorded this attack as caused by *Aphis atriplicis* Linnæus, having taken Buckton's definition of the species as being correct. On referring back to the specimens and comparing them with those of 1911, I find they are the same, namely *Aphis rumicis* Fabricius. Jablonowski* also refers to this insect as attacking mangolds, sugar beet, etc.

* Die Tierischen Feinde du Zuckerrüte, pp. 221-228, Budapest, 1909, J. Jablonowski.

Schouteden* places *Aphis chenopodii* Schr. as synonymic with *A. atriplicis* Linnæus.

Aphis atriplicus Linnæus is a totally distinct aphis from the black *rumicis* which I found only in patches. Instead of curling the leaves and crinkling them up it forms markedly boat shaped galls. In 1911, the first year that I have observed it, specimens were taken on mangolds at Herne Bay, Seasalter and Faversham and at Wye on Mangolds, and two colonies on the Sugar Beets and also in abundance in the village on a small creeping goosefoot (*Chenopodium polyspermum*) and near Boughton and in Wye village on *Atriplex portulacoides* (Plate XXIII.).

Here and there on the mangolds it was doing more harm than the black aphis, in spite of the fact that it was not so generally disturbed. This aphis is green, usually very pale green, as one would expect, owing to its secluded habits, it has a mealy coat and is very sluggish and in the galled leaves I always found many mealy oil globules, such as one finds in the curled elm leaves caused by *Schizoneura ulmi*.

The female apterous form settles on the upper side of the leaf on the mid rib and then soon produces living young. Their combined punctures ten days later have the effect of causing the sides of the leaf to curl upwards and gradually they meet over the mid rib and form a nearly closed tube. The galls were found packed with aphides in July and August, and on September the 25th a few nymphs appeared. These all died off in the galls, and in spite of the great numbers kept under muslin out-of-doors in breeding jars I never obtained a single winged female.

Hayhurst† in America, has obtained winged and sexual forms of this insect which is undoubtedly the same as occurs in Britain.

During the first week in August, in New York State, he got winged females, which left the galls in great numbers, a general migration apparently being at its height.

Connold, in 1902, observed a similiar migration in this

* Catalogue des Aphides de Belgique, Mem. de la Soc. Ent. de. Belg. XII. p. 216, 1906.

† Observations on a Gall Aphid (*Aphis atriplicis* Linn.), Annals Ent. Soc. America Vol. II., No. 11, pp. 88-99. 1909.

country. These migrants appear merely to go to other similar plants, as Hayhurst found sexual individuals late in September on them, and these occur on the seedheads where the ova are deposited. The ova he describes as being yellow at first and in a few days black. They were placed irregularly on the seed capsules and on the calyces and on the small leaves of the upper branches of *Chenopodium*. In this way the eggs are carried by the seed when moved and distributed by wind. As Hayhurst remarks, the oviposition of this aphis on the seeds and seedheads explains its world-wide distribution.

Chenopodium album, one of its food plants in Europe is known to have been introduced into America, whence it has followed the trail of the early American settlers.

The two other species I found at Herne Bay, both evidently undescribed which occurred only in small numbers will be dealt with elsewhere.

Schouteden also considers *A. papaveris* Fabricius, *A. evonymi* Fabricius, to be the same as *Aphis rumicis* Linnæus. They appear to me to be all the same. The insects wintering as eggs on the Spindle Tree (*Euonymus*).

Prevention and Treatment.

There is no doubt that the chief damage in 1911 was done by the poppy aphis, which is the same as the dock and bean aphis. Poppies, especially the wild red poppies, were smothered with it, and their migration to the mangolds was definitely traced, moreover all the dozens of preparations made from these plants revealed that they were one and the same species. Moreover it was where wild poppies were most abundant that the damage to the root crop was most severe.

In Wye, a district where poppies are not so very abundant now, the attack on the roots was clearly traced to a small area around the College being sown with Shirley poppies which were smothered with this blight. Just the same around Herne Bay. It is obvious, therefore, that this bad weed, showing poverty of soil and bad cultivation when in fields, should be eradicated as far as we can. It is a too frequent weed along newly laid-out building land, such as was noticed on the seaboard of Thanet. They form a standing danger

at any time in spreading this pest. Its winter and spring quarters being the *Euonymus*, where it is known as *A. evonymi* is important to note. These bushes should be destroyed when possible.

The others evidently both wild Chenopodium feeding species are of minor importance, but nevertheless their food plants should be eradicated whenever possible.

Some experiments were made with spraying for this aphis attack, and as far as destroying the pest on beets in gardens, it is well worth doing. Whether it is worth doing in the field is a matter of opinion.

Four rows of beets badly attacked were sprayed with paraffin jelly, two rows being left. The spray was sent out on to the plants and ground with force, and it was found that sufficient of the spray rebounded and soaked into the plants to destroy a very large percentage of the dolphin. There was a marked difference at the end of the year between the sprayed rows and the two left untreated, so much so, that the two untreated rows were scarcely worth lifting. With a potato sprayer much good can undoubtedly be done in field work.

On a few plants soft soap and quassia was used, but its effects were not quite so rapid on this aphis as with the paraffin jelly. On the whole, however, it is preferable to use.

It may be pointed out that in this great blight of 1911 I never came across any Ladybird Beetles or their larvæ feeding upon the aphides on mangolds, in one case only a few Syrphidae and not a single hymenopterous parasite was bred out of some hundreds kept for this purpose.

ANIMALS INJURIOUS TO PULSE.

The Small Pea Leaf Miner (*Agromyza scutella* Fln.)

From several districts in Kent pea plants were received in which the leaves and stems were badly mined by small dipterous larvæ differing from the larger leaf miner.

Specimens were sent to the British Museum and were named by Mr. Edwards *Chlorops. sp.*

In a subsequent letter he says it is quite a distinct insect *Agromyza scutellata* Fln. and Mr. Collins who has examined this small fly thinks it may be that species, but expresses a doubt as Fallens species is a seaside insect in Britain.

Agromyza scutellata Fln. has so far been recorded as only mining the leaves, etc. of *Vicia cracca* and *Veratrum nigrum.*

It was reported from Herne Bay, Margate, Lydd and was also found near Ashford and Maidstone. It is quite a distinct species to that I recorded in the report for the year ending April 7th, 1906, p. 81, under the name *Phytomyza pisi,* n. sp. The fly is much smaller, and the larval mine relatively much smaller.

The plants received had no larvæ in the mines, all had pupated before they were received.

The damage although not so great as in the Phytomyza attack was sufficiently serious to be called attention to.

It was advised that all attacked haulm should be burnt at once, as the peas were said to be valueless.

ANIMALS INJURIOUS TO HOPS.

The Needle Nosed Hop Bug (*Calocoris fulvomaculatus* De Geer.)

This hemipteron did considerable damage to some hops at Style Place, Tonbridge, in June, 1911. The Fuggle leaves sent showed typical Needle Nosed Hop Bug damage as I recorded and figured in No. 2 of the College Journal.* Some hills at Style Place were struck low down and had not grown much, some were struck on the top. The disease came in patches in the garden. About fifty hills in every three hundred were found to be damaged. "Some can never get up to the wire and cannot have any hops" the grower wrote.

In 1895 this insect which I have only seen once or twice since did a considerable amount of damage to several growers near Tonbridge. This bug and another *Anthocoris nemorum* Fall. were first brought to my notice by my old colleague, Mr. H. Monson, who did so much in starting the South-Eastern Agricultural College.

The effect of the *Anthocoris* was always in doubt, and in my original paper on these pests I took the view that it was an enemy. Seventeen years have forced me to quite alter my opinion.

In 1886 the hop crop around Canterbury was attacked by a bug. *Anthocoris nemorum* Fall was found and it was supposed to be the destructive agent, and in the proceedings of the Entomological Society of London was recorded as being harmful around Canterbury, but Mr. C. O. Waterhouse was of opinion that the Jumper (*Euacanthus interruptus*) was the cause of the damage complained of.

* Notes on the Needle Nosed Hop Bugs. F. V. Theobald. *Journal of the S.E.A.College*, No. 2, pp. 1-14, September, 1895, and No. 4, pp. 9-10, October, 1896.

There is no doubt whatever that Mr. Waterhouse was correct, and that myself and the growers were wrong, for *Anthocoris nemorum* is a beneficial insect, which is not only a plant feeder of little or no importance, but an active enemy of aphis. Many times since then have I seen them sucking the body juices of plant lice.

The true Needle Nosed Hop Bug, sometimes spoken of as the "Shy Bug," attacks the bine and the foliage. It punctures by means of its long piercing proboscis the tender parts of the bine, and not only draws out the sap, but leaves behind a wound from which the sap flows for some days in small globules. This wound, when healed, is recognised by a distinct scar.

When many of the bugs attack the bine it ceases to grow, and throws out a dense growth of low laterals. This is a very noticeable sign of the attack of this *Calocoris*. It was first called to my attention near Tonbridge at the beginning of June.

This insect also punctures the leaves, especially the young, tender leaves at the top of the bine. Holes are formed, and these split and a ragged, crumpled, stunted appearance is produced.

The adult is about one-third of an inch long, it is dark olive brown in the male, paler in the female, sparsely clothed with dull golden pubescence ; the apex of the second segment of the antennæ, the centre of the head, two spots on the thorax (pronotum) black (the two latter faint in the male). The elytra are parallel sided in the male, widened behind the middle in the female, the membrane of the wing is dark with a light spot near the apex of the cuneus ; the femora of the legs are mottled with dark brown, the tibiæ are ochreous, with short, dark spines.

Life-history.

The adults I found deposited eggs on pieces of bine in 1896, and some of these hatched out on May 5th in the following year, but in 1900 I found this insect again in the immature stage, in the winter, so it cannot be said definitely which is the normal method of hibernating.

The earliest larval stage I have records of is after the first moult.

The larva, after the first moult is then about one-sixteenth of an inch long. The head and pro-thorax are brown; the meso, and meta-thorax greenish-brown, darkening in some specimens towards the hind border. Eyes dark brown to black. Antennæ of four segments, nearly as long as the body, the second segment from three to four times as long as the first, pale brown, the two terminal segments darkened. First two abdominal segments reddish-brown, third and fourth yellowish-green, remainder of abdomen reddish-brown in the centre, darkening towards the tip, except a few of the anterior segments, which are yellowish-green at the sides, the green extending downwards from the third and fourth segments.

Legs of moderate size, pale brown; femora darker at the base, tibiæ and tarsi dark at the distal extremities.

After Second and Third Moult.—After the second moult, the larvæ alter in shape, but the general coloration is the same. The four-jointed antennæ are pale, reddish-brown, the second segment dark at the tip, the fourth also dark brown. Eyes dark, pro-thorax chestnut brown with a pale stripe in the middle; front of meso-thorax pale greenish-brown, dark brown towards posterior edge; meta-thorax dark chestnut brown. First two or three abdominal segments bright yellowish-green, also the sides of three or four of the other segments; central part of the abdomen chestnut-brown, apex greenish. Legs long and slender, reddish-brown, speckled with minute black specks on the femora which are dark; tibiæ armed with small black spines, dark chestnut brown towards the tip. Venter bright green, except in front, where it is darkened. Length when full grown one-sixth of an inch. There is little difference between the last larval stages.

The nymph is chestnut brown, except the first two abdominal segments, and the pleuræ of the next three or four segments. Tips of the wing buds dark and shiny black. Antennæ pale brown, very dark towards the tips. Eyes black Legs speckled with dark brown, with black spines on tibiæ and femora; tarsi dark brown, coxæ silvery grey.

On the venter the abdomen is bright green in the centre, chestnut brown at the sides. Length one-fourth of an inch. The nymphs are variable like the larvæ, some have almost

fleshy coloured legs and very bright reddish-brown, ventral markings. The greenish-yellow markings are also subject to some slight variation.

The smallest larvæ I received were only one twenty-fourth of an inch long, these I received on May 4th, one under observation moulted on May 20th, then again on May 27th, the fourth moult took place on June 5th. The nymphal stage remained until July 4th, when the imago hatched. Most, however, in the open had matured by June 20th.

Sir Charles Whitehead wrote me that the winged bugs had appeared at Maidstone on the 6th, but at Tonbridge they appeared much later.

Habits and Food Plants.

This bug is most active during bright sunlight, and in the middle of the day. It is most timid, and runs round the bine or pole the minute it is seen . On jarring the poles the adults either fly off with a curved downward flight, or else fall straight down on to the leaves, etc., below.

This species has been observed on various Umbelliferae, on Ash, Birch and Hazel. Douglas and Scott record them on black currants at Darenth. Mr. Edgar Mercer, of Capel, informed me in 1895 that it was very abundant on his currants in the previous year, and that they had spread from the currants to the hops.

It has never been known to do any damage to currants, however. It is found mainly in gardens where poles exist, and is seldom found where wire and string have superseded poles.

The places where I originally observed it in the field were, at the farms of Mr. Tollhurst, Fine Oak Green, Mr. Bugge, of Church Farm, Capel and Mr. Claveys, Capel, and later at Mr. Pemple's farm. Sir Charles Whitehead told me it occurred in the Maidstone area, and it seems to be fairly widely distributed over Kent in small numbers. I also found it on hops in the Farnham district in Surrey in 1900 and once observed it on hops at Guestling in Sussex in 1886.

Treatment.

The adults are practically impossible to deal with, but the larvæ and nymphs may be readily jarred off, as is done with the " Jumper " on to tarred boards.

Mr. Pemble in 1896 tried this method, and wrote me as follows : " I tried the jarring, and caught a larger number of the bugs before they became winged."

Washes they found to have little or no effect upon even the younger stages.

Things, however, have altered, and it is now known that a combination of nicotine and paraffin emulsion will destroy the larvæ and nymphs of these hemiptera.

When a bad attack is seen it is certainly worth while to spray for them with a mixture of these substances.

The paraffin jelly which I have always found the best formula should, however, only be used at the rate of 10-lbs. to 60 gallons of water instead of 40 gallons on hops. The nicotine at the rate 3-ozs. to the 60 gallons is sufficient.

Red Spider of Hops (*Tetranychus malvae*).

At the end of September a sample of earth taken out of a hop hill was sent from Prince of Wales, Hunton, with the note that there were small red egg-like bodies in it, and they occurred generally in the hills.

On placing the soil in bright light it was at once seen to be swarming with small red acari which proved to be the common Red Spider of Hops (*Tetranychus malvae*). They were very active when in the light, running about between the particles of soil and burrowing into it.

They lived in the soil until the end of January, when it was unfortunately allowed to dry up for some days, and the result was that most of them died.

I am not aware of any previous record of this Tetranychus entering the soil in the autumn, and do not know if it will prove to be one of its normal wintering places.

Some considerable damage seems to have been done in 1911 by this mite.

Mr. Mannington reported it as having been very troublesome at Yalding, and wrote asking if it was dangerous to use the bine in his bullock yards. As I have several times found red spider on ripening bine, and as it is said to live there in winter, the inadvisability of keeping bine in stacks was apparent. It is extremely unlikely, however, that these acari could possibly survive being trampled on in bullock

yards. The winter habitat of the hop red spider is evidently not settled, and the record of them being found in such numbers in the soil may lead to the final conclusion that their normal winter quarters are under ground, and anyway they survived a long while in the soil in which they were sent me.

OTHER HOP PESTS.

Eelworm (*Heterodera schachtii*) from Paddock Wood and Malling.

Strig Maggot (*Diplosis humuli*).

This was reported twice during the year. Mr. Best, of Suckley, Worcester, wrote saying it was doing his hops a great deal of harm.

Mr. G. Phillips, of West Malling, Kent, that his garden was sometimes infested with this insect, and in patches it did a great deal of harm.

The Hop Dog (*Dasychira pudibunda*).

This hop insect was sent from the Harper Adams Agricultural College, Newport, Shropshire, with a request for information concerning it.

Hop Aphis (*Phorodon humuli* Schr.)

This was sent from Evesham on May 29th, just becoming winged from plums.

Black Aphis (*Aphis rumicis* Fabricius).

This was reported from hops several times in July Small colonies round in form, appeared, but died off.

ANIMALS INJURIOUS TO VEGETABLES.

Flies (*Limosina curtiventris* Stnh.) attacking Rhubarb.

A considerable amount of injury appears to be done to rhubarb roots by insects, especially where it is grown in large quantities. Several enquiries have been received from near Leeds regarding this damage. Mr. Harold Avery, of Blue Hill Lane Farm, Wortley, wrote saying as follows: "I send one root for your inspection we have now 500 affected this way. When we plant the rhubarb roots we plant them free from disease as far as we know. As far as we know they do not seem to be attacked the first year, and they grow well; then when we take them up to force, they are as the one sent; sound ones are twenty times larger, and of the forcing value of one shilling, so you can estimate the enormous aggregate loss to market and other gardeners in the Leeds district where it is generally present."

In another letter received the following was written:— "I can say without doubt that many thousands of pounds of damage is done by maggots in this extensive rhubarb district. The only knowledge we have is that the plants are attacked all round the buds, the maggots eat them off the lower forcing roots, and then the plants are worthless. Early forcing roots are worth one shilling a piece, and some here take up 10,000. What the potato disease is to that crop, these maggots are to the rhubarb industry here."

The root and subsequent ones received were in a very bad state, and were smothered with small maggots, and had also a lew larger maggots of the *Bibionidae* (Plate XXV. B.).

The small maggots all hatched out into hosts of little black flies, which Mr. Collin identified as *Limosina curtiventris* Stnh. (Plate XXIV. A.) That these were the chief cause of the damage is evident, for large numbers of the flies were put in with some quite sound roots, and kept under muslin in the

open, and by next year they were in a similar state of decay, and large numbers of flies hatched out from them.

There are no less than thirty-five species of the genus *Limosina* Macquart, recorded in Verrall's list from Britain. These small, dark flies belong to the family known as *Borboridae.*

The larvæ have the end of the body elongated into a short tube, which bears stigmata at the end. They are recorded as feeding in fungi, algae, diseased potatoes, and in decaying substances.

Many species of Limosina are extremely abundant, often occurring in vast swarms. Some inhabit seaweeds on the coast.

Curtis* refers to these flies, one of which (*L. geniculata* Macq.) he bred from rotting potatoes.

Mr. Rayer also observed a species in rotting potatoes named by Guérin *Limosina payenii.*†

It may seem, therefore, that the small black flies bred from the rhubarb stocks were only feeding in their larval stage on the decayed roots. On the other hand no other insect or fungus could be found in any number sufficient to cause the decay, and fresh healthy stocks were used by the larvæ which developed there and the roots decayed.

Rhubarb root stocks have numerous dead scales, and it is probably amongst these that the Limosina settle first of all.

Snow Flies (*Aleyrodidae.*)

Snow Flies or *Aleyrodidae* are often looked upon as small moths. They are, however, quite a different group of insects, and are allied on the one hand to the Scale Insects (*Coccidae*), and on the other to the Aphides (*Aphididæ*).

They are all small, delicate creatures, the adult males and females having four wings, rounded at the tips thickly coated with mealy white powder, hence their popular names Snow Flies and Powdered Wings. Their mouth is in the form of a three-jointed rostrum or beak, which contains setæ or bristles, by means of which the plant tissue is punctured.

* "Farm Insects," p. 465, 466.

† Bull. des Séances de la Soc. Roy. et Cent. d'Agric. V., plate 6, fig. 4.

The females may lay their eggs either singly, but more usually in clusters on the lower side of the leaves of various plants.

The larvæ coming from these ova live under round or oval glossy coverings, much like the scale of many *Coccidæ* and beneath these tests they pupate (Fig. 7, D.)

In some these bodies have many radiating processes.

The adult insects (Fig. 7, A.) are active, so much so that a plant covered with them gives off a cloud of these snow-like insects when shaken even very lightly.

Colonel Clementi of Cullompton, Devon, wrote saying: " They come out in clouds like very fine snow, and the wind blows them all over the garden, every plant of cabbage, cauliflower, sprouts, broccoli, savoys, kale, etc., are attacked and three fourths of my vegetables are lost."

A number of species of Snow Flies are known in the world, and many more remain to be described.

In Britain Miss Ormerod referred to the Cabbage Powdered-wing or Snowy Fly as *Aleyrodes proletella* Linnæus and *A. cheledonii* Latr. The species she referred to is evidently the common *Aleyrodes brassicae* of Walker. *Aleyrodes cheledonii* Latr. is a synonym of Linnæus' *proletella*.

Another common and destructive species is *A. vaporariorum* Westwood, which was thought to be a native of Brazil. It is now found all over Europe and America, mostly in greenhouses, and also in Hawaii. Another species (*A. fragariae* Walker) occurs rarely on strawberries in England and France, another on the oak (*A. quercus* Signoret), is often very common.

The ova (Fig. 7, B.) are marked in structure, having a process at the side at one end. One of the most destructive species in Britain is the Brassica Feeder (*A. brassicae* Walker), which has recently caused very great loss in Devon and Dorset. In Devon Colonel Clementi wrote saying they were killing all the green stuff at Cullompton ; at Exmouth also entire crops of brassicæ of all kinds were ruined. A bad attack was also reported from Longham, Wimborne, Dorset, in September, cabbages being literally covered and killed by them there. Enquiries were also made from Sellinge and Frittenden in Kent concerning the Cabbage Snow Fly this last year. The young stages suck away the sap and cause pale patches to

appear on the leaves above. The pale patches turn brown later. This insect may continue to breed right through the winter in this country, and so keeps on doing harm for a long period.

As far as is known the larvæ soon become covered with a glassy scale, which becomes opaque white, showing two yellow spots. In from eight to twenty days the larvæ change to the

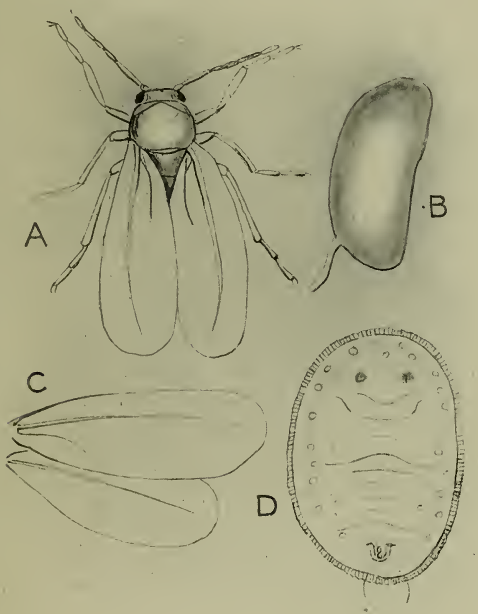

Fig. 7.

A. Adult Snow Fly. B. Egg.
C. Wings of Adult. D. Immature Snow Fly under scale.

pupal stage, which is pale yellowish, with red eyes. From four to ten days after pupation the adult winged insects emerge from beneath the scales.

The adults measure about one-eighth of an inch across the expanded wings.

The species found under glass known as *A. vaporariorum* Westwood, is often very harmful to tomatoes and cucumbers. They sometimes so smother the tomato fruits that they have

to be wiped before being marketed. It attacks many other plants.

Prevention and Treatment.

Of the many substances tried, the only effectual remedy in the open is soft soap wash and the more potash in it the better. *Frequent* spraying with potash soaps usually proves effectual. Paraffin emulsion is an excellent killer, but of necessity cannot be used on green stuff except when young. Nicotine has no effect at all on these insects, as a spray, except upon the adults.

Frequent sprayings with soap washes is all we can do in the garden when the vegetables are ready to cut.

It is important that all outside leaves should be destroyed in any convenient way as well as the stalks. As the creatures also shelter to some extent in the ground, the land should be dressed in winter with Vaporite or some other of the various soil fumigants.

Under glass Snow Flies may be destroyed by fumigating with pyrethrum cones or nicotine preparations.

Mr. Emptage tells me that fumigation with sodium cyanide is also most successful for the *Aleyrodes vaporariorum* under glass.

The cyanide is used at the rate of 1-oz. to every 2,000 cubic feet of space in small houses. This is generally sufficient. In large houses $1\frac{1}{2}$-ozs. unless there is much room between the laps when 2-ozs. may be needed to every 2,000 cubic feet. If the plants are quite dry and the temperature not above 60° F. little harm will be done to the plants.

The Cabbage Aphis (*Aphis brassicae* Linn.).

The Cabbage Aphis (*Aphis brassicae* Linn.) was most harmful in 1911. The year was perhaps one of the worst we have had for aphis attack in general and the total loss caused by this species alone must have amounted to some thousands of pounds.

It was particularly reported from near Wimborne, in Dorset, in September, where it was said to have caused much loss.

Mr. Saunders, B.Sc., Biologist of Holmes Chapel Agricultural and Horticultural College, also wrote concerning this

aphis which had done a great deal of damage amongst cabbage, swedes, etc., in Cheshire.

On November the 3rd he sent me a large parcel of attacked cabbages, swedes, etc. All were badly infested with thousands of aphides, and many were literally blackened with eggs. I had never seen such a mass of eggs of Aphididæ before. They were laid on the stems mostly in the cabbages and on the bases of the leaves, in the swedes mainly at the crown, but individual ova were laid here and there all over the leaf surface.

The plants were smothered still with viviparous wingless females, but there were also large numbers of oviparous females and winged males.

I found a few specimens of two other species present.

On October 29th dead swede leaves were found covered with the eggs at Holmes Chapel.

Earlier in the season a green aphis which had been identified as *Aphis rapae* was said to be present in the ratio of one to three.

When I received the material the green aphis was in the ratio of 1 to 10,000 of the Cabbage Aphis (*brassicae*). The third species I only obtained a few specimens of.

The *Aphis rapae* of Curtis has always been looked upon a synonym of *Rhopalosiphum dianthi* of Schrank. The third species I found is quite distinct.

The specific distinctions of these aphides I have not yet worked out, and are referred to a later date. The Cabbage Aphis (*A. brassicae*) is undoubtedly the cause of all the damage

Considerable loss was also caused by it in various places in Derbyshire during the year, and it made its appearance in large numbers in some parts of Essex.

The Cabbage Aphis (*Aphis brassicae* Linn.) is the same as *Aphis raphani* Schrank and Moseley, and the *Aphis floris-rapae* of Curtis.

The apterous viviparous female (Plate XXVI. B.) is bluish to greyish-green in colour covered above and below with white meal, there are seven to eight small black spots on each side of the back; the cornicles are short and black, so also is the short tail, whilst the short antennæ are green with dusky tips.

The larvæ are at first pale yellowish green, and devoid of a mealy coat, some are almost yellow.

The nymphæ are mealy like the females and have the wing buds dark. The winged viviparous female (Plate XXVI.A.) has a yellowish green abdomen, head, neck and thorax black and there are also dark transverse bars on the abdomen and lateral dark spots; the cornicles are short and brown.

The oviparous female is pale yellowish green, eyes black, abdomen with a double row of five or six dark patches extending along the centre; cornicles cylindrical and dark.

The male is winged, head dark, thorax greenish brown, abdomen pale greenish-brown to yellow, with four black spots on each side and a double row of six dark patches along the centre; cornicles dark.

This aphis usually first shows itself on the under surface of cabbage, cauliflower, sprout and swede leaves as the wingless female. Having settled down she produces living young, and thus a colony is started, after a time this colony, covered with mealy powder and with many oil globules about them, cause the leaves to swell upwards, forming a pallid blister on the upper surface; as they increase the leafage curls up. Later they work their way down to the bases of the leaves, and in Brussels sprouts collect in masses in all the sheltered parts. Winged viviparous migrant broods are produced at no fixed time and these fly to other brassicæ and start afresh. This goes on until the autumn when the oviparous or sexual generation is produced. Besides being found on cultivated plants it occurs on Shepherds Purse (*Capsella bursa-pastoris*), and on Charlock in small numbers.

The ova are at first yellow, in a couple of days or so they become black; in some they were almost green at first.

Although numbers of Syrphid larvæ may be found amongst them, and great numbers are parasitised with small hymenoptera of the genera *Trionyx*, *Ceraphron* and *Coruna*, I have never known them control a bad attack in the least, in fact I have noticed that these aphidivorous creatures never appear in any numbers until the aphides have increased so enormously that the damage has been done.

Prevention and Treatment.

So great is the damage in some years caused by this insect to green stuff, that it is necessary to take steps to check it, even over large breadths of plant.

Two things I have seen done by growers, one is to wash the plant with knapsack sprayers, giving them a good soaking with soft soap and quassia, or if fit to cut or pick soon with soft soap alone. The other plan which did not seem to act as well was dusting with a powder distributor—such as the Coronet Duster, with a mixture of pepper and fine road dust.

As the eggs seem to be laid on both leaves and stalks these should be always burnt before February when possible, and later cut stuff burnt as soon as can be.

After an attack on swedes the leaves must be ploughed in deeply and the land well pressed.

Potatoes Damaged by Springtails (*Sminthurus luteus* Lubbock).

A bad attack of yellow Springtail (*Sminthurus luteus*) on potatoes was referred to me on the 26th of June, from Marden. The grower saying the potatoes were fast growing as the specimen sent and covered with little yellow skipping insects. (Plate XXVII.)

I have already reported this apteron as damaging potatoes and there is no doubt that in certain places it does a considerable amount of harm. On the other hand I am confident that a very similar ragged and stunted appearance of the leaves is caused by the green larval and nymphal plant bugs, which I have on two occasions found in numbers on potatoes. Curtis refers to two bugs (*Lygus solani*) and the Frog Fly (*Eupteryx solani*) damaging the potato foliage by piercing it.

Acari attacking Potatoes.

In January some potatoes were received from Jersey for examination as many were rotting. They had been imported from California and it was feared some new disease might be introduced into the island.

Great care should be taken to examine all introduced potatoes owing to the possibility of that serious potato enemy the Potato Moth (*Lita solanella* Biosduval) coming to this country.

The tubers sent showed no signs of that pest, but were covered in places with acari, and it appears that they were partly the cause of the decay. Numbers were placed on sound tubers, and they seemed to produce very little effect upon them.

Others were placed on tubers that had been bruised and the skin lacerated. At once the acari swarmed to these areas, and soon reduced them to dark, wet diseased masses.

The tubers if lying together soon rotted after the acari had once got at the damaged parts.

Thus, indirectly the mites do a good deal of harm.

Mr. Dunlop, writing later, said he also found all the undamaged tubers free from attack.

Two acari have been recorded as attacking potatoes namely :

(1) *Rhizoglyphus robinii* Clap.

Found by Claparede with *H. dujardinii* upon hyacinths, dahlias and also potatoes. This mite is recorded as having very thick and clumsy third pair of legs, which occupy so much space that they throw the fourth pair further back than usual.

(2) *Rhizoglyphus* (?) *feculae* Guerin.

Great numbers found in some heaps of Australian potatoes shut up in a barn at the annex to the Imperial farm at Vincennes.

The potatoes which looked quite sound and healthy were covered with these acari.

Mushroom Mites.

The enemies of the Mushroom under cultivation seem to be a serious drawback to their growth.

Aptera such as *Achorutes rufescens* Nicolet (Vide Report 1910, p. 103 and 122), are a source of loss. Woodlice often do much harm and various larvæ of the fungus gnats (*Mycetophilidae*) destroy them.

Mites, however, seem to be the worst enemies.

A common species found in mushroom caves and beds is *Rhizoglyphus echinopus* Fumonze and Robin, the mite usually spoken of as the Bulb Mite and also recorded technically as *Rhizoglyphus sinitarsus* Canestrini. (Plate XXXIII., B.)

Another species frequently found in mushroom beds and on the gills is *Tyroglyphus mycophagus* Megnin. It is mentioned by Michael as being found on decaying fungi and in decaying cabbage stalks and other vegetation. It appears, however, to attack sound mushrooms when the gills are showing.

An inquiry came from Lancing in February, 1911, concerning the damage done by acari to cultivated mushrooms in that neighbourhood.

The culprits in this instance proved to be *Tyroglyphus siro* Linnæus, a mite so common in cheese, flour and other dry animal and vegetable products. Another species sent with it was *Histiostoma rostro-serratum* Megnin, but according to Michael this species which was originally described from specimens wading in great quantities in the thin film of liquid which covers decaying mushrooms is a follower and not an initiator of decay. There is no doubt, however, that several acari are very harmful to the fungi.

They may be cleared from the beds by spraying the floors, walls, etc., and the beds themselves with a 2½ per cent. solution of lysol and a small quantity of soft soap, about 3-ozs. to 10 gallons.

Knot Root Disease (*Heterodera radicicola* Greeff.) (Plate XXVIII.)

This disease, due to an Eelworm (*Heterodera radicicola*), was reported from Swanley in March, 1911, where it was badly damaging Tomatoes under glass. Also from Erith in Kent. The disease is also present in Hertfordshire in large glass-houses, and causes great loss and inconvenience. Although this disease now frequently appears out of doors, whilst formerly it was confined to tomatoes, cucumbers and melons under glass, it does not seem fortunately to make any headway in the open.

Its evil effects in houses is very great, but by sterilising the soil by heating up to 200° F. the eelworms are all killed,

and eelworm-free soil may be obtained. Russell has shown that sterilization by heat completely cleans the soil of the parasitic eelworms, and that they do not soon return, whilst other free living forms may do so.

I recently had the pleasure of seeing Mr. Randall's method of sterilizing soil, and the very healthy cucumbers grown in it without manure.

The danger lies in manure. One frequently sees the dead tomato and cucumber plants thrown into a manure heap to rot. As the galls decay the eelworms escape into the manure, and may in that way be carried to houses in which the soil is free from these insidious pests.

It is most essential that all plants should be burnt when removed from the houses, not only those which show the Knot Root, for a few of the Heterodera may be on others, and these may carry infection to another house.

It is quite likely that soil sterilization on a large scale will come into general use, anyhow for cucumbers. With tomatoes the amount of soil to be treated would be so great that it is doubtful it it can become of much value.

OTHER VEGETABLE PESTS.

The Celery Fly (*Acidia heraclei* Linn).

Several enquiries were received from Kent and Surrey during the year. The general failure of celery in gardens was due to drought, and this helped the fly, which was particularly abundant. (Plate XXIX).

Remedy for Club Root.

The following communication was received from the Tunbridge Wells Chrysanthemum and Gardener's Mutual Improvement Association: "One of our members always plants his cabbage with a trowel, first taking out the soil and putting in some ashes in the bottom of the hole, and then fills up with ashes making sure to completely cover up the roots with the same. The ashes are taken straight from the stoke hole. This has completely stopped clubbing and many other of our members have found the same." This is well worth trying

in every garden where it can be done, as lime in a finely divided state, all that can be used on a large scale is only an ameliorative.

Wireworm in Potatoes.

A bad attack of wireworm in potatoes was reported by Mr. H. Wright, of Kirton Lindsey, Nottinghamshire. The larvæ did £100 worth of damage last year, and on the same land were now badly attacking the Corn. Rolling both ways with a ring roller and top dressing was advised.

ANIMALS INJURIOUS TO FLOWERS.

The Orchid Borer (*Xyleborus morigerus* Blandford).

In the Board of Agriculture Journal (Vol. IV., No. 4, p. 474, March, 1898) some notes are given on an Orchid pest which was named " *Xyleborus perforans* Wall."

The Orchid Borer is not that species which was described by Wollaston and which attacks sugar cane and wood such as beer staves, etc., in India and elsewhere. (Plate XXX., A.) This wrong naming appears to have been copied, for in Mr. Sander's new book on " Garden Foes " he mentions *Xyleborus perforans* as being an orchid enemy.

Feeling certain that the orchid species was quite distinct from *X. perforans* specimens were referred to Mr. C. J. Gahan, of the British Museum who identified them at once as *Xyleborous morigerus* of Blandford, described from orchids in " Insect Life " (Vol. VI., p. 260). Mr. Gahan noted that *X. perforans* of Wollaston is of a very different shape, being relatively much longer and narrower. Typical damage caused by this species to wood is shown in Plate XXX. A, as a matter of interest.

Some badly attacked *Dendrobiums* were sent me through the *Gardener's Chronicle* from North Britain. The orchids attacked were *Dendrobium dalhousieanum* and *Dendrobium superbens*. The orchid mentioned in the Board *Journal* was *Dendrobium phalaenopsis*.

Blandford in his original descriptive notes merely refers to it as " very destructive to newly imported *Dendrobiums*." His correspondent only mentioned the fact that it was injurious to the plants, and gave no locality or the species of *Dendrobrium*. But later in his notes Blandford says : " The nurseryman who imported the orchids has informed me that the species of orchid in question came from New Guinea. Mr. Blandford had reason to believe, however, though the nurseryman had not informed him of the fact, that the insect

had been destructive in his houses and so he did not feel sure it had been confined to its native species. It is extremely probable, however, that its home is New Guinea.

Damage done.

The damage is done by the beetles boring into the aerial roots and stems and by the larvæ which come from the eggs they deposit. The external symptoms are shown by a few small holes about the size of No. 16 shot. (Fig. 8, I. *a*). The greatest number of holes observed was ten in one piece of stem a foot long. The only other external signs are the wilting of the shoot, and the gradual death of the plant. On cutting the stems open longitudinally, a short transverse tunnel is seen running from the hole inwards for about 2 to 3 mm., in one thick stem for 5 mm. This tunnel gives rise to a chamber (Fig. 8, II. *a*.) of varied size, in one stem nearly half an inch across, in another only one-third of an inch, its size depending on the size of the stem. This is the breeding chamber and in it I found always one to five mature beetles ; in one case some larvæ. It is lined with an opaque shiny grey growth, a kind of " ambrosia " and thus probably the adults as well as larvæ feed upon this fungoid matter. This chamber becomes a wet, dark mass and the dark coloration spreads to the surrounding tissue. In one specimen this dark discoloration extended for over an inch above and below the brood chamber.

From this cavity I could only trace a single gallery sometimes it ran upwards, but at other in a downward direction. (Fig. 8, II. *b*.) The longest gallery observed was an inch in length. Blandford says " It attacked the bulbs and aerial roots and stems of the Dendrobiums sent. The parts injured were about one-sixth of an inch in diameter and were channelled out by longitudinal burrows."

In the Board of Agriculture *Journal* it is said that " these galleries are simple, running up and down the stems, others had branches at right angles, but in most cases one short branch was noticed." In all the specimens I have seen there is only one lateral gallery and that is formed primarily by the mature insects entering and that aperture is used also for the escape of the progeny and all later broods.

I watched a female enter an old hole, and she had not emerged two weeks later. This female had previously been

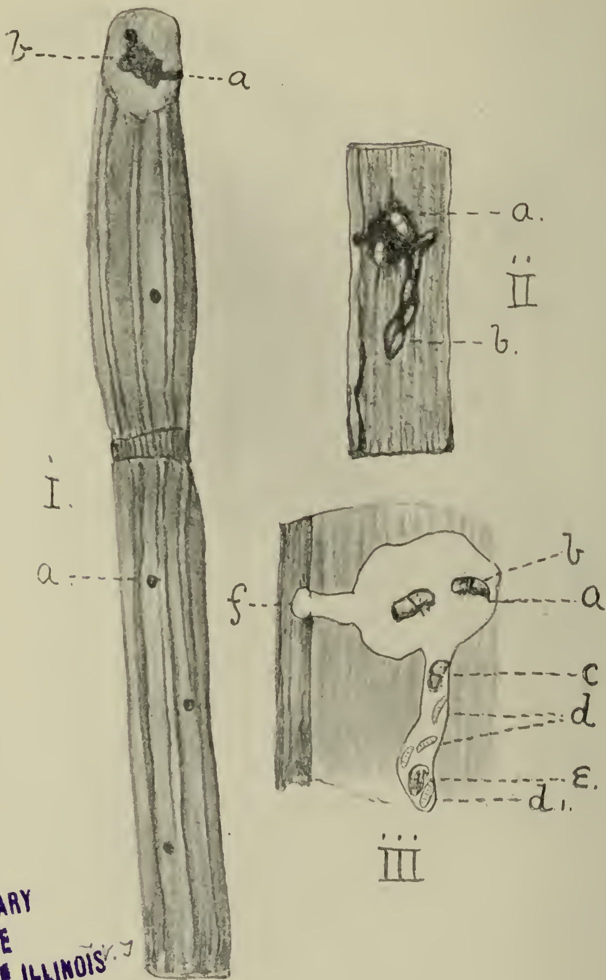

Fig. 8.

Xyleborus morigerus Blandford.

I. Dendrobium showing *a* exit holes, *b* brood chamber; II. *a* brood chamber, *b* larval chamber; III. *a* brood chamber, *b* and *c* adults, *d* larvæ, *e* pupa; *f* entrance and exit hole (Enlarged).

in copula with a male in the same tube. If the brood chamber is used for sexual purposes, why do the adults escape at all? In this case I feel sure the males and females escaped, copulated outside, and then the females entered the plant and commenced egg laying.

Perhaps the unnatural conditions in which they were kept altered the usual natural proceedings.

I noticed only six males out of the large number of insects that were bred out. In only one case did I find a male in the brood chamber.

The specimens of orchids sent me on December 3rd had young and mature larvæ, and pupæ in them.

On December 7th four beetles emerged, by December 14th thirty adults had appeared and by the 16th eighty-seven more escaped. On January 1st two more matured, and by January 4th seven were found in the tube.

On January 16th I opened this shoot and found twelve immature beetles, six small larvæ and three pupæ in one nest.

Some sound Dendrobium shoots were put in with four females and a male on December 10th and by January 26th these shoots were opened and mature larvæ and pupæ were found in them and also small larvæ. On the 28th beetles commenced to appear, but had not yet left the gallery. In this particular case one female bored her way into the Dendrobrium and a second female used the same entrance hole. Both were found ten days later in the same brood chamber, which was not nearly as large as most I opened and from which adults had been emerging for some weeks.

I have been unfortunate in not finding the eggs which are apparently laid in the brood chamber. All together in a foot of Dendrobium kept 142 adults have been bred between December 7th and January 28th. It has been impossible to trace the actual length of stages as one cannot follow what happens inside the plant, but enough has been seen to show that under favourable circumstances reproduction is continuous and the broods overlap. Apparently the life cycle takes forty-nine days but the beetles remain for some time in the orchids before escaping. The pieces of Dendrobium were kept in glass cylinders plugged with fine cotton wood in a temperature of 60° to 65° F. In the Board *Journal* it is stated that "In most

cases the galleries or branches end in a deep pocket, in which eggs, larvæ, pupæ and perfect beetles are found."

This was not so in any of the specimens I have seen.

The beetles bore into the orchids and form a small chamber. This becomes lined with "ambrosia," and here the beetles seem to remain and then form a small gallery. In this gallery young larvæ, mature larvæ and pupæ occur, not only side by side but all over one another. (Fig. 8, III. *c.* and *e.*)

"Ambrosia" occurs also in the gallery. As the beetles mature they make their way to the brood chamber, and there they may remain for some time before escaping. One piece of Dendrobium cut open on January 1st showed six beetles with the larvæ and four in the brood chamber. On the 17th three came out of the exit hole, and on the 18th one. On the 20th two more, but on the same date there were still several in the gallery, and these have not yet emerged (January 29th). The time the beetles took in actually escaping from the exit hole varied from one to eighteen hours. They seemed to remain in the exit hole until sunlight fell upon them.

On one occasion a beetle was found with its head at the exit hole just protruding at nine o'clock. It escaped the next day at three o'clock on being placed in the sun. On another occasion a beetle was seen to appear near the exit hole at one and on the tube being placed in the sun in a window it emerged between two and three o'clock on the same day.

It seems that temperature, moisture and light regulate the emergence and metamorphosis of this Xyleborus to a remarkable degree. In a hot house they, no doubt, can and do breed all through the year, and in consequence may cause endless loss to very valuable plants.

The adult, larva and pupa.

The beetle is very small, the female being about 1.8 mm. in length, the male about 1 mm. in length. The colour is very varied, immature forms are pale, ochreous, with a dusky apex. Mature forms are rich bright, chestnut-brown, and have a distinct dark area on the apex of each wing case, which in some specimens merge and become one dark area. The head, as in all the Xylebori is well hidden under the thorax when viewed dorsally. The antennæ are small, and have

swollen apices. The thorax is very nearly as large as the elytron covered abdomen, very convex, and the anterior half has hairs and concentric depressions, whilst the posterior half is smooth with small scattered punctures and a small median patch of pubescence above the scutellum.

The wing cases are nearly as wide as the thorax, and not quite half as long again (Blandford says half as long again), the sides are nearly parallel, but near the base they are strongly rounded, humped in the middle and with a strong declivity at the apex ; they are finely punctured in lines, and towards the apex there are longish hairs.

The small male is a pale testaceous yellow, with long, yellowish pubescence, and is flattened and more oval in form than the female and the thorax is broader than long.

The larva is opalescent white and when mature about one-fifteenth of an inch long, and has a darkened head.

It is straighter in form than the usual Xyleborus larvæ I have seen.

The pupa (Fig. 9) is pale, yellowish brown to dull, creamy yellow, and on the head are seen two dark crescent-shaped little eyes and a dark oval area between, and the apex of the body is also darkened.

Fig. 9.
Pupa of
Xyleborus morigerus.

It is advisable to have even a valuable orchid cut right back or destroyed whenever this pest is seen to prevent it spreading. It may do endless harm, if allowed to breed, in spite of the fact that the beetles seem very sluggish in their movements.

The Cattleya Fly (*Isosoma orchidearum* Westwood) **and a Cecid** (*Cecidomyia cattleyæ* Molliard) **Galling Cattleyas.**

Specimens of damage done by these insects to orchids were sent from Bakewell, Derbyshire.

The Cattleya Fly belongs to the hymenopterous family of *Chalcididae*, most of which are parasitic in other insects and their eggs.

Isosoma is a genus in the sub-family called *Eurytomidae*, many of which are plant feeders forming gall-like swellings on the stalks and shoots of various plants.

The Cattleya Fly attacks the pseudo bulbs, and other parts which swell up and now and then turn black. (Plate XXXI.) The gardener noticed swellings on the young leaves of a *Cattleya gigas*, as well as the swellings sent on the roots. It appears to have been introduced on the *Cattleya gigas*, and to have spread to others. The perfect insect is black with transparent wings, and about one-fifth of an inch long.

It was originally described by Westwood* from England and is now widely spread over the world. In 1888 it appeared in greenhouses in Paris, and was investigated by M. Künckel d'Herculais (Ann. Soc. Ent. de France, 1888, Bull, p. 23). Westwood had previously referred to it in 1869.†

Fig. 10.
Anchor Process of *Cecidomyia cattleyæ.*

It is also found in America where in some places as California it is very common.

It is found to be especially fond of *Cattleya gigas*, *C. trianaei*, *C. eldorado*, *C. labiata*, *C. mossiae*, and has been found on *C. labiata-autumnalis*, *C. amethystoglossa*, *C. Bowringiana*, *C. Gaskelliana* and *Laelia purpurata*.

The larvae eat and develop inside the tissue of the plants, as a rule only one larva occurred in each cell, but it is recorded in America that three to eight were found in the cavity.‡ The larvæ pupate inside the galls, they are white and change into light coloured pupæ and from there the Chalcids eat their way out leaving behind round holes.

In addition to this Chalcid which undoubtedly gnaws the tissue and produces galled swellings, other larvæ were found, of an orange colour. These larvæ left the galls and pupated amongst the moss in which the roots had been placed. They proved to be Gall Midge larvæ (*Cecidomyiadae*), and apparently are Molliad's *Cecidomyia cattleyæ.*§

Cecid larvæ forming galls have been often noticed both in England and America.

* Transactions Entomological Soc. London, 1882.

† *Gardener's Chronicle*, p. 230. November, 27th, 1869.

‡ "Insect Life." Vol. II., p. 250.

§ La galle du *Cecidomyia Cattleyæ*, n. sp. Marcellia, Padova, Part I., pp. 165-170, pl. II. (1902).

At one time owing to the fact that dipterous galls occurred upon orchids in which Isosoma was present, it was thought that the latter was parasitic on the former.

An instance recorded in America is referred to* in which the galls were situated near the tips of the roots. The galls when opened contained from one to seven maggots, separated from each other by the substance of the root. This pest seems to have been introduced in a plant from England, and had spread to others around it.

The anchor process of this orange cecid larva is very marked (*vide* Fig. 10).

Molliard records this Cecid on the following Orchids, *Cattleya sanderiana, C. Mendeli, C. Warneri, C. Mossiae, Laelia purpurata*. Very diseased plants should be destroyed unless of great value. It is possible to extract the larvæ from the galls with a fine pointed knife, and if they are not too numerous this surgical treatment is successful.

Narcissus and other Bulb Flies.

Of especial importance at the present time is the so-called Narcissus Bulb Fly (*Merodon equestris* Fabricius) on account of the Board of Agriculture having scheduled it amongst the notifiable diseases.

It has usually been looked upon as the chief bulb pest.

Some hundreds of bulbs have been sent me owing to their being diseased during the past twenty years, and in them very many *Merodon equestris* have occurred, in some cases every bulb sent being affected. In private purchases also from the continent and from home many have been found to be attacked by these dipterous larvæ.

On the other hand, since 1903† a more careful examination has shown that in many cases *Merodon equestris* was not the culprit at all but the larvæ of *Eumerus strigatus* Fln.

Previously, I feel sure, from what I know now and in reference to an old note made in 1885, I had mistaken the smaller larvæ of the *Eumerus* to be younger instars of the *Merodon* and this in spite of the very marked character of the former.

* "Insect Life," III., p. 22, 1891.

† Second Report on Economic Zoology for the British Museum, p. 74, 1904.

Two forms of larvæ were also noticed by Sir Charles Whitehead in 1896, who in the Board of Agriculture Journal (Vol. III. No. 3., p. 287, 1896) says of an attack in Cornwall, "In some of the bulbs there were two larvæ." This evidently applies to the *Eumerus*.

This *Eumerus* attack is not confined to England, for during the past year I found great numbers in bulbs sent from Ireland. In some of these bulbs the *Eumerus* was the sole cause of damage, in others it occurred alongside with a single *Merodon*. Although not nearly as large as the *Merodon*, it is quite as harmful owing to its being present in the bulbs in greater numbers.

It is best therefore, to deal with these two different syrphid pests separately, in spite of the fact that they work in a very similar manner.

For practical purposes I will call them the Large Narcissus Bulb Fly, and the Small Narcissus Bulb Fly.

The Large Narcissus Bulb Fly (*Merodon equestris* Fabricius).

This fly belongs to the section of the family *Syrphidae* which includes the well-known Rat-tailed Flies *Eristalis* called Eristalinae. In fact it bears a passing resemblance to some of that genus, such as the common *Eristalis intricarius* Linné, so much so, that I have frequently caught this species for one of the extraordinarily variable *Merodon*. For unlike the male *intricarius* which hovers high in the air, the female, I find, often settles lazily on plants just as does the *Merodon*.

The *Merodon* found in Britain and originally described by Fabricius is most variable in colour, so much so, that certain well marked varieties have been described as separate species. I have found not only all the well marked and described varieties for years in my own garden, but many others which have not been, and all occurring at the same time.

In general appearance this fly looks much like a worker humble bee, but its more rapid flight, its sudden movements, at once disclose its identity. (Plate XXXII. A. and C.)

The so-called typical form—the species—does not agree with the commonest type I have met with. I thus only

mention the varieties which seem to me to occur in their ratio in this country.

Variety *Narcissi.*—This has always proved with me the commonest form.

The thorax is thickly clothed with rich tawny hairs, the abdomen similarly coloured but slightly paler ; from a rich tint, one can catch them down to a paler and duller hue which is not entirely due to age.

Variety *Equestris.*—In this, the next commonest form I have met with, the thorax has pale tawny hairs in front, black behind and the abdomen with greyish haired base and rich fulvous on the remainder.

Variety *Validus.*—This I have only found in small numbers, but Verrall* says it is the usual form found in England. The hairs are all black except towards the tip of the abdomen where they vary from dull grey to almost white.

Variety *Transversalis.*—This I have only seen one specimen of, the hairs are all dull grey except for a black band on the third abdominal segment.

A specimen of this variety is also recorded by Verrall as having been taken by Mr. Bradley on May 28th, 1893, at Sutton Coldfield.

In addition to these recorded varieties, I have met with specimens in which the general colour was black and the apex tawny. Tawny specimens with a dark band on the thorax. Tawny specimens with pale apex, a few banded almost as in *Hypoderma bovis.*

All the legs are black and in the males the hind tibiæ are markedly humped inside and have a conspicuous spine or process at the tip, in the female the hind femora have a distinct tooth near the the tip. In size they do not seem to vary much, the average size being nearly half an inch in length.

Reaumur, in 1788, was the first to call attention to their insect. At that time it was common in France. It is said to have spread to Holland in 1840, and from thence to England and America. It has also made its way in bulbs to New Zealand, but is not established I believe.

* "Syrphidæ of Great Britain," p. 588, 1901. Verrall.

Localities in Britain.

The first record I have of this fly is in 1882, when it was common in my father's grounds at Kingston-on-Thames, it occurred on and off for some years after and then died out. It was found to do a certain amount of damage. In 1884 I found it in a garden at Ealing.

In 1889 I found it commonly amongst wild daffodils in many places in Somersetshire. In 1890 I took several in my uncle's rectory grounds at Swinshead in Huntingdonshire. In 1895 I found it in King's Wood, Wye, and in the next year onwards in small numbers in my garden until 1909 when it occurred in great numbers and on until 1910.

Infested bulbs have been sent me from Penzance in 1897; from Chertsey in 1902 and 1903 and 1911, from Ham, Surrey, in 1899, from Weymouth in 1899, from Eynsford, Kent, in 1897, from Maidstone, Kent, 1898; from Great Staughton, Hunts, 1899; from Walton, Surrey and Taplow, Berks, in 1900.

Bulbs of *Narcissus princeps* were also sent in November, 1911, from Ottenshaw, Surrey, badly infested with both maggots.

Walker* records it as "very rare, found in Northamptonshire."

Verrall† Denmark Hill, South London, 1869; Bradley records it from Sutton Coldfield and round Birmingham since 1892 in abundance, and later, Verrall says "from Botusfleming, in Cornwall, to Tilgate Forest, London, Rugby and Birmingham." The extensive attack of this fly in Cornwall reported in the Board of Agriculture Journal‡ was at Penrhyn a reference was also made to Penzance.

Chittenden records it in bulbs from Norwich, but these had been imported from Holland, and it is also recorded from Lyndhurst§; Wilks received it from Lanarth.

It thus appears to be very widely spread over England, to occur in Ireland and what is more important it exists in out of the way places were I have found it in Somerset and in

* "Insecta Britannica," Vol. I., 252. (1851.)

† "Syrphidæ of Great Britain, p. 886. (1901.)

‡ *Board of Agriculture Journal*, Vol. III. No. 3, p. 287. (1896.)

§ *Gardener's Chronicle*, July 8th, 1911.

Kent in a wild state, which I clearly think shows that it is not entirely an importation.

Dr. Wilks says "I do not believe any garden exists in this country where 1,000 bulbs are grown where you could not find *Merodon equestris* among them." In this I quite concur.

Doubt has been cast on Walker's record in 1851 and Verrall claims to have taken the first British specimen in 1869. There is little doubt that it has always existed as a native insect amongst the wild daffodils in the west and other parts of the country.

At the same time it is well known that many are imported in bulbs from the continent, where it is also very common, especially in Holland.

Food Plants.

The larvæ are common in hyacinths, tulips and narcissi, I recorded them in *Vallota purpurea* in 1897.* I have found them in Galtonias; McLachlan records it in the bulb of Eurycles, an Australian genus and on two occasions I have found it in the bulbs of the wild hyacinth or bluebell, both in King's Wood, near Wye, and in Devon. It is probable that this also forms one of its native food plants as well as the wild daffodil. Chittenden records it in Habranthus bulbs, in Vallota, and Mr. Wilks has found them in the bulbs of lilies.†

A footnote in the same article gives bulbs of Hippeastrum as being attacked also.

Is it an introduced species?

There will always be a matter of personal opinion on this point. Mine is that it is a native, based on the fact that it is found wild and has been for many years far from habitions and that it occurred in abundance in my isolated garden in 1894 where no bulb had been imported for years, and that I have found it in the blue bell, where wild daffodils did not exist.

That great numbers are imported in foreign bulbs we know, and that it is introduced in this way is, of course, certain, and has done much to spread it over the country.

* *Journal* S.E.A.College, No. 6, p. 22, 1897.

† Journ. Roy. Hort. Soc. XXXVII., plate 1, p. 122, 1911.

Dr. Wilks who has studied this question says there is very little doubt that it was first imported from Holland thirty years back, this was written in 1902, that is in 1872. Verrall, however, took it in 1869.

As infected bulbs can only be detected when the larvæ are half grown it is extremely difficult to see how their introduction can be stopped except by total prohibition, which if bulbs are properly dealt with in this country is not necessary, and particularly when we consider that it is *now* anyway a wild insect and that no one can dispute. Mr. McLachlan, one of our greatest entomologists, wrote on this insect* that "The undoubted fact that *Merodon* is becoming more common here than it was formerly is, no doubt, mainly due to the large importation of bulbs of narcissus from the South of Europe. A friend of mine, a noted horticulturist, never observed any signs of the ravages of its larvæ until after having purchased, in an unlucky moment, a bag of imported bulbs; since then it has occasioned great damage in his garden. Bulbs of narcissus (and probably of other plants) that have been attacked by *Merodon*, but not killed outright, are found next season to have divided themselves into a varying number of healthy bulbs, so that, to some extent, the attacks of the larvæ form a means of propagation." Nothing further need be said of this from a practical point of view. That they have this effect I am quite convinced and that the persistent presence of this fly amongst my own daffodils left in for some years has so weakened and spoiled them that they had to be mostly destroyed is undoubtedly the case.

Amount of damage done.

In the Board of Agriculture Journal Vol. III., No. 3, p. 287, a Cornwall grower reported that he had to destroy several thousand bulbs of *Narcissus stella* and *Narcissus gloriosa*.

Life-history.

The flies, as far as I have observed, appear at the time the daffodil and narcissus foliage commences to die off. The earliest note of its appearance I have is April 29th, the latest June 1st. Dr. Wilks records it as late as July 12th. Larvæ

* Entomologists' Monthly Magazine, XXXI., p. 114.

reared by me from specimens sent from Chertsey in 1903 commenced to hatch on April 29th, and continued until May 15th.* The flies appear all much about the same time in any one year, and do not seem to last on the wing longer than two weeks, the maximum flight being a little over eight days. I have never seen them except on bright sunny days on the wing, then from ten in the morning until about three they were noticed in great activity. They settle on the dying leaves, and may remain basking in the sun for some minutes, then they dart off and, where I watch them, along a garden path, frequently fly some thirty yards away and settle again. Their flight is most rapid and makes it quite impossible to catch them on the wing, but they may easily be caught in a net when settled on the foliage. They make a most characteristic noise when flying, which cannot be described and one can readily detect their presence before they are seen.

Frequently they crawl down amongst the dying leaves and I found laid their white eggs on the exposed parts of the bulbs on two occasions, most on the necks. It is said that the flies may live for two months, and during that period deposit over a hundred eggs laid singly over that time. This is not what I have observed. As far as observed the first maggots about one-sixth of an inch long were found on July 7th. On August the 15th others were found but slightly larger. Up to December 30th I have found many maggots, and a few as late as February 22nd.

When full-grown they reach over half an inch in length. They are of a dirty grey to yellowish brown colour, the skin is wrinkled, the head is to some extent flattened, but may taper when extended, there are two mouth hooks almost black in colour and over the mouth two reddish divided horns, on the caudal end a dark projecting excrescence, with two spiracles and on each segment a bristle. (Plate XXXII. A. 1.)

These larvæ are very sluggish and feed inside the bulbs eventually reducing them to a wet decayed mass in the interior, which sticks to their skins.

It is said that the maggots enter from the base. I do not think this has been conclusively proved. Its supposition lies in the fact that attacked bulbs have usually, as far as I have

* Second Report Economic Zoology, British Museum, p. 74, 1904.

observed, a hole at the base, but I have only observed this in bulbs in which the larvæ are in an advanced stage.

From the position in which the ova are laid and the position in which I have found the young grubs I am sure they tunnel down the neck to the base just as Dr. Wilks has described. I found some eggs on the leaves and probably the larvæ crawl down them to the neck.

Pupation is said in the Board of Agriculture *Journal* referred to to take place in a slight silken cocoon. This I have never seen. Pupation takes place in a puparium case—the old larval skin—and is of the form shown in the figure. (Plate XXXII. A. 2.)

The puparium I have found in the diseased bulbs, seldom in the soil surrounding them.

The puparia are dirty grey in colour, elongate oval in form, with two anterior projections.

The presence of a hole at the base of attacked bulbs does not occur until some time after the bulbs have been invaded.

If the bulb is destroyed before the maggot is mature it eats its way into another one, sometimes at the base or side, at others near the top. This applies not only to bulbs in the ground but also when stored.

Detection of diseased bulbs.

Early infection cannot be told, but after a time the necks of the affected bulbs become soft to the touch if pressed with the fingers. Later the hole is seen at the base, and then speedily the decay sets in.

Prevention and Treatment.

It is important to destroy all infested bulbs and never to plant any that show the least symptoms of having been attacked.

The maggots cannot be affected when young by any treatment, but if they are advanced and when an opening is made to the exterior they may be destroyed by fumigating them with hydrocyanic acid gas. The bulbs must be well dried first.

Another treatment that has met with success is to plunge the bulbs into water heated to about 120° F., and leave them in it for some ten minutes.

By far the best thing, however, is to keep a look out for the flies, and catch them with a butterfly net. I have caught hundreds in this way and quite cleared them out of my garden, at least only one or two were seen after this had been done.

The flies can be easily caught when settled, but it is useless to try and catch them on the wing.

I tried various baits recommended such as honey and treacle, and also "tanglefoot," but caught very few in this way.

Ritsema Bos suggests soaking the bulbs which are suspected for eight days in water, so as to drown the grubs. Some I treated in this manner did not yield good results.

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The Small Narcissus Bulb Fly (*Eumerus strigatus* Fln).

This fly is evidently common in bulbs in Britain. I originally found them in bulbs sent from Chertsey in 1902, and reported in 1904.* I have twice found them since in considerable numbers in bulbs sent from Folkestone and from Ireland and a few in bulbs from growers that I have purchased. The only flies hatched from these were identified by Mr. E. Austen, as *Eumerus striatus* Fln. (Plate XXXII. B.). Other references undoubtedly to this species have been given earlier in this paper.

The larvæ are much smaller than the *Merodons*, the average length being one-third of an inch.

In the bulbs received from Chertsey in 1903 I counted as many as ten in one bulb, in some received from the same place in 1911 I counted as many as seventeen. In bulbs received from Dublin I found a few in several bulbs and these decayed just as readily as where *Merodon* was present.

They may occur side by side with *Merodon* or may be the sole agent of decay. Not only are they very much smaller, but they can be told by the more pronounced caudal chestnut brown blunt process.

The adult *Eumerus strigatus* Fallen, also described as *E. lunulatus* Meigen, is a little more than one-fourth of an inch long. Its thorax is shiny and dark, almost metallic with a pair of faint pale lines on the front with longish pale brownish

* Second Report on Economic Zoology (British Museum), p. 74. 1904. F. V. Theobald.

yellow hairs ; the abdomen is short and shiny black with metallic hues, sometimes greenish reflections, with short pubescence of a dirty white colour especially on the fourth segment. The legs are thick and black with the base of the tibiæ reddish and some reddish coloration on the feet, the hind femora are markedly dilated and the hind tibiæ curved and enlarged.

Their general appearance reminds one of a group of bees known as *Halictus*, which Verrall says they appear to mimic, for what reason this resemblance takes place I do not know, for I have never seen them together.

Verrall records it from Penzance, Christchurch, Darenth, Abbey Wood and Lee in Kent, Bucks, Cambs and Hunstanton ; he records it from these localities from July 8th to August 25th, whilst Colonel Yerbury took it at Christchurch on May 23rd.

Those I kept from Chertsey hatched on May 17th, and went on appearing until July 3rd.

Bouche* bred this species and another *E. aeneus* now considered the same from onions which they were found to have destroyed and he refers to the fact that they may destroy a crop of onions wholesale. There is no record of them attacking onions in this county.

Bouché found the larvæ in July in onions, and they pupated in the bulbs or in the earth.

Those I have found and bred in narcissus and hyacinth bulbs were all found in the winter. Whether the maggots last from May to July over the winter, or whether there is a second brood is not known, but probably those found in the onions were only nearly mature larvæ from early hatched May and June flies, and if the onions were left in the soil would pupate in the manner of *Merodon*.

There is no doubt that these small narcissus and other bulb flies are the cause of much loss, but are not, it seems, so widely spread yet as *Merodon*, still the numbers one finds in samples of bulbs purchased shows that it has to be dealt with just as much as the larger maggot.

It is undoubtedly the smaller maggot referred to by Whitehead and Wilks (*vide Merodon*).

* Stett. Ent. Zeit., p. 145, 1847.

The Carnation Maggot (*Hylemia nigrescens* Rnd.)

This fly was reported in 1911 as doing a good deal of damage to carnations in the Egham district.

The fly lays its eggs on the leaves and the maggots eat their way into the leaves where they form tunnels presenting pale streaks on the leaves. They work down to the centre of the shoot, feed on the pith and so destroy the shoot. The full grown larva is about one-third of an inch long, and changes to a brown puparium in the dead shoot.

No treatment is known for this pest, but hand work, cutting off the attacked leaves and pulling off the diseased parts and burning them.

An Introduced Rhododendron Pest (*Stephanitis rhododendri* Horvath).

This bug was sent me by Mr. H. F. Carter, who had received it from Kew Gardens where it was attacking the Rhododendrons. Mr. Distant recorded it from Fulham in 1910 ("The Zoologist," Fourth Section, Vol. xiv., p. 395). It was originally described by Dr. Horvath ("Anns. Mus. Hung.," iii., p. 567, 1905), from specimens found on rhododendrons in Holland. This beautiful little Hemipteron belongs to the family *Tingididae*. The genus exists in British India, where it is represented by four species. Both Dr. Horvath and Mr. Distant consider this to be an introduced species. Probably it has come from the Himalayan region, the home of the rhododendrons.

As this is the second record in Britain it looks as if this introduced species had taken a firm foothold.

The Bulb Mite (*Rhizoglyphus echinopus* Fumonze and Robin.)

On June 29th specimens of English and Spanish iris bulbs were received from St. Leonards on Sea smothered with the Bulb Mite (*Rhizoglyphus echinopus*). (Plate XXXIII. B) The disease first seems to have appeared there some years ago, and destroyed many Turks Cap Lilies, then the ordinary white Lilies were destroyed, then the mites attacked Zinnias, Stock and Harpalium and also Rudbeckias.

This year the mites appeared on the roots of Wallflowers and a patch of Alstromerias was damaged.

This is a most destructive mite and appears to inflict considerable loss on gardeners, nurserymen and bulb growers.

The favourite food is undoubtedly the bulbs of tulips, hyacinths and lilies, especial damage has been recorded to *Eucharis* lilies. It has also been found in large numbers in potatoes and dahlia tubers, in onions, on oats, on the roots of vines, and as recorded here on mushrooms.

Owing to their getting into the scales of the bulbs and breeding there, they are extremely difficult to destroy. Some experiments have been conducted by Mr. Jemmett, but no certain remedy appears to have been found at present.

Fumigation with nicotine does not seem to kill very many.

The best method seems to be to dry the bulbs off and then subject them to the fumes of hydrocyanic acid gas. Some doubt has been cast upon the habits and harm done by this creature. A good many people think that it only goes to already unhealthy bulbs, bulbs attacked by eelworm, Narcissus Bulb Flies and fungi. Certainly one finds them most abundantly in decaying bulbs.

It also appears most difficult to get them to affect or even take up their abode on sound bulbs, on the other hand they at once settle and breed on bulbs that have in any way been damaged.

Mr. Jemmett had great difficulty in getting them to settle on sound bulbs, and when some did they did not breed at all rapidly.

On the other hand, the great authority on Tyroglyphidae, Albert Michael, writes as follows : " I have usually found that it prefers sound bulbs and will leave decayed ones and establish itself in the fresh ones if they be placed close to it and even when it is in a partly decayed bulb the greater number of specimens will be found at the junction of the sound part and the decayed, steadily eating their way into the former and leaving decay behind them."*

So far I have never found this mite on bulbs that have not been attacked by some other disease, in a great many cases eelworms have been the actual cause of decay—the mites

* "British Tyroglyphidæ." Vol. II., p. 94.

being secondary. In others, for instance, in two lots sent in 1911 from Ireland, mites swarmed, but the bulbs were also infested with Bulb Fly maggots. If they are not the actual primary cause of disease, they certainly hasten decay and a slightly damaged bulb which would otherwise be all right for planting will soon fail under the attack of these mites. All diseased bulbs should be burnt and the soil in which they have grown should be heavily dressed with vaporite. The usual remedy advised is to wash the bulbs in sulphide of potassium, at the rate of 1-oz. to three gallons of water. I have found, however, that many of the mites escape.

The most satisfactory treatment I have found is to clean the bulbs, remove any rough outer scales, and soak them for five minutes in water at 140° F.

Rose Pests.

Among the insects attacking roses sent me by the Secretary of the National Rose Society during the year have been the following :—

Brown Scale (*Lecanium persicae* Geoff.) Abundant on rose shoots, no locality given.

A species of *Hylotoma* which could not be identified at the British Museum which was causing a good deal of harm to roses at Hong Kong.

The eggs are laid by the female sawfly in slits cut in the shoots and this causes them to die off.

Several instances of *Otiorhynchus* weevils, especially *Otiorhynchus picipes* eating rose shoots and foliage and buds were also recorded.

The Pepper and Salt Moth (*Amphidasys betularia* Linn.) was also sent by the National Rose Society as attacking roses, no locality was, however, given.

ANIMALS INJURIOUS TO FOREST TREES.

The Elm Bark Beetle (*Scolytus destructor* Oliv.)

A request was received by the College from the Kent Education Committee on August 30th to investigate an attack on a number of trees "on the frontage of the County School, Ramsgate, which have been attacked by worm and are in a dangerous condition."

In the following week I visited the County School, and found nearly all the elms around it in a bad condition, some were dead, others dead at the top, and all but a few past recovery. A casual examination showed that the cause was the well known Elm Bark Beetle (*Scolytus destructor*), which does not only attack unhealthy trees, but also those in a sound condition. Many of the trees were full of larvæ, not only low down but up to a height of fifteen feet, the least attacked trees had the pest only up to about ten feet high. Two trees were also at once detected as being invaded by Goat Moth (*Cossus ligniperda*) by the very strong smell emitted by the larvæ. A number of elms looking sound grow in the Public Library grounds next the school and others in some private property behind the County Council land. On the first visit I did not examine carefully the trees in the Public Library grounds, but I detected one with traces of the Elm Scolytus.

The following report was sent to the Ramsgate Corporation and the Local Higher Education Sub-Committee :—

REPORT *re* BEETLE DAMAGED ELMS AT RAMSGATE.

"SIR,

" I beg to report that I visited the County School, Public Library, etc., at Ramsgate in September 4th in order to examine the state of the trees surrounding the former building. I found the elms in a very bad state—eight or nine dead

—several so damaged that it is doubtful if they will live over the season, and all more or less seriously diseased.

"The cause is an attack of the Elm Bark Beetle (*Scolytus destructor*). In two instances the Goat Moth (*Cossus ligniperda*) is also doing damage.

"This attack is evidently of long standing, and should have been attended to some time ago. A few trees surrounding the County School may possibly be saved, but most are doomed, The Elm Bark Beetle has also spread to one or two of the trees surrounding the Public Library.

"Unless something is done the beetles will invade all the elm trees around, and cause their destruction.

"At present the trees around the School form a bad disease centre which should be destroyed as soon as possible. I consequently advise the immediate cutting down of all dead trees, grubbing up the roots and barking the cut trees at once, and burning the bark and stubs. It would be well to top all dead wood at once of those trees that might be saved.

"The only treatment likely to do good is to bark all the trees that show any signs of attack as was done in the Botanic Societies' Gardens in Regent's Park in 1842, with success.

"The trees want divesting of all the rough *outer* bark. Care must be taken to go deep enough to destroy the young larvæ on the infested parts.

"Then the trunks up to the large boughs should be thickly coated with a mixture of lime and clay in the form of a thick paint and covered again in mid-May with the same. The old stumps of elms used as flower receptacles should be burnt as the beetles were also breeding in one of them.

"One tree attacked by Goat Moth was dead, and should be cut down and burnt at once. The other can be treated with cyanide of potassium.

"If the Council wish, I will go down again, and see to the operations myself.

"I am, Sir,

"Your obedient servant,

"FRED V. THEOBALD.

"Wye,

"*September 5th*, 1911."

On October the 25th, at the request of the Public Library Committee, I examined the trees in their ground, and after a careful search found only one tree badly attacked. The following report was in due course sent to the Chairman :—

[Copy.]

"South-Eastern Agricultural College,
"Wye, Kent.

"To the Public Library Committee,
"Ramsgate.

"Gentlemen,

"I beg to report that I visited the Public Library on October 25th to inspect the elm trees, which are in proximity to the infested trees around the County Council School.

"Many of the trees did not show any sign of the presence of the destructive Elm Bark Beetle (*Scolytus destructor*), only one was badly attacked ; this, and a second unhealthy tree, I advise should be removed and barked at once.

"Those trees which show signs of the pest should be treated this winter. The insects may be removed by taking off the outer bark and crushed in the manner I showed the attendant, who is also looking after the treatment of the trees at the County School. By April the trees should all be dressed up to ten or twelve feet with a thick mixture of clay and lime.

"It would be advisable to see if the elms at the back of the two buildings (which I hear are to be cut down owing to building operations) could be cut and barked before next April.

"I will visit the trees again soon to see if the work of removal of the insects is being carried out satisfactorily.

"I am, Gentlemen,
"Your obedient servant,
October 27th, 1911. "Fred V. Theobald."

Life History and Habits of the Elm Bark Beetle.

The Elm Bark Beetle the *Scolytus destructor* of Olivier, the *Scolytus geoffroyi* of Goetz is one of the bark beetles or Scolytidae which, as far as we know, at present only attacks

the elm. Kollar,* however, refers to it attacking fruit trees, etc., and describes an attack on plum trees at Grinzing near Vienna evidently mistaking *Scolytus pruni*, for this beetle although he says he found no difference between the specimens. He certainly figures the Elm Bark Beetle and mentions that it attacked and destroyed a great many elms (*Ulmus campestris*) in the islands in the Danube, *viz.*, those in the Prater, and that a more extensive general attack was, by the activity of the ranger, Baron Binder van Kriegelstein, completely prevented by merely felling and carrying off the attacked trees. It is very common and most harmful to elms in this country. I have seen many fine elms destroyed by it in Surrey and bad attacks at Hastings and Cambridge, whilst around London it has done much damage. In fact, wherever the elm flourishes the Scolytus is usually present. Its incipient attack frequently passes notice, and it is not until the elm bark begins to peel or the trees to die that any notice is taken of it. It is usually then too late to do any good, whereas the attack in the beginning may be stopped. I remember some twenty-two years ago one particularly fine elm at Kingston-on-Thames was attacked, and as it provided shelter just where it was wanted we did all we could to save it. The drastic method advocated of barking the tree was tried, and it survived until cut down on the estate being built over. As pointed out later this drastic treatment is not necessary to destroy the brood.

The beetle usually starts its work in one tree, and this forms a disease centre as soon as it is so badly damaged that there is not enough food for the copious progeny of young.

The beetle's life cycle is well known, and is briefly given below.

The beetles appear at the end of May, and may continue until mid-June. They are about one-fourth of an inch long, black in colour on the thorax, which is large and longer than broad, whilst the wing cases are reddish-brown to black, the legs and antennæ dark ferruginous. Gillanders† describes the abdomen as light brown, this never occurs in southern specimens.

* A Treatise on Insects, p. 265.

† "Forest Entomology," p. 94.

The females work their way along the large cracks or crevices of the bark, and apparently widen them, throwing out much wood debris. In some seen at Ramsgate this pri-primary tunnelling ran to two inches. They then enter into the bark, nearly to the sapwood, sometimes right into it. Then a straight tunnel is formed between the bark and the sap wood from two to, in one case observed, six inches long. It has been stated that it takes the female three weeks to form this so-called "Mother Gallery." (Plate XXXIV). Having been fertilized by the males, which appear soon after the females, the ova are deposited, the number being estimated at between 100 to 260 for each female.

The eggs are laid at the sides of the mother gallery; as they hatch into maggots the latter bore their way outwards, some at right angles, those above and below at an angle. Many of the larvæ die, being crushed out by others and hence many abortive tunnels are found. At first this gallery runs parellel with the sapwood, but as the larvæ mature they turn upwards and consequently the grubs are found *in* the bark as they are nearing maturity. It was in this position I found the larvæ in my visits to Ramsgate, an important point to note because the rough outer bark can be easily removed without doing the least harm to the trees.

The insects are mature by April and May. They are creamy white, fleshy and with wrinkled skin, legless and have the first three segments somewhat swollen. They pupate in the bark close to the surface, the first pupæ I found on March 2nd, but I believe many enter this stage before then.

Soon after the beetles hatch they eat their way through the over-lying bark and escape by exit holes so characteristic of an attack of this pest.

The beetles then set to work again and the larvae mature by the end of July to the middle of August, when the second flight of beetles appears.

Thus there are two distinct broods as far as my observations show.

Miss Ormerod describes the attack as I have seen it in many places excellently. She says, "the greater number of grubs, however, appear to pass the winter either just within

the wood or in the thick bark and so come out as beetles in May."

The large pieces of thick red bark which can easily be cut and often broken off old elms I found at Ramsgate to be teeming with the larvæ in November, none could be found lying near the mother gallery close to the sapwood.

The galleries are most marked on the bark and only in a few cases were very prominent designs left on the wood itself, in any case the scarring is faint compared to that on the inner surface of the bark.

The opinion often expressed that only unhealthy trees are attacked is one that I do not hold with in the least. In some dozens of cases I have seen perfectly healthy trees that would have lived for very many years attacked and killed by this beetle. It is true that an attacked tree continues to be attacked and that as long as there is ample food supply the beetles remain there, but as soon as a certain point of unhealth approaching the end of the life of the tree the beetles fly to the nearest tree, sound or not, and there set to work.

That they breed in dead stumps, etc., I have failed to discover, although I have naturally found them in stumps of recently cut trees, and, moreover, they may mature there, but as actual breeding centres they may be discarded, nevertheless, it is advisable to have all stumps drawn so as not to let those that are in them when the trees are felled, mature.

Generally speaking, the beetles attack the trunks up to a height of ten to fifteen feet, but as the trees fail and in time they work up quite high. In the trees at Ramsgate, some top branches were even attacked but such is unusual and in all cases the trees were first attacked low-down. The presence of the larval colonies could be easily traced by following the commencing tunnels of the females in most cases and cutting into the bark at once revealed the larvæ.

Treatment advocated.—It was at once seen that quantities, probably most, of the larvæ in November could be destroyed by cutting off the rough outer bark. Hundreds were cut out in this way and in no case was it necessary to get down near the sapwood. Consequently, this method was adopted on all trees likely to be saved. The worst were cut down, barked at once, and the stubs grubbed and barked and all bark

and refuse burnt and the wood cut and disposed of in the winter.

The lower part of the trees near the infected area were to be dressed with a thick puddle of lime and clay and this had to be repeated if worn off in April, as it is found to prevent the females from entering the bark. It is most important that any single badly diseased tree be felled and barked in winter so as to stop an attack from spreading and any other trees slightly attacked have the larvæ removed in November or December by pealing off the rough outer bark.

The method of cutting down to the sapwood has been advocated. It is not necessary, as far as I have observed. This was successful, however, as recorded in the *Gardener's Chronicle* in Regent's Park in 1842, and certainly so is the one fine elm I treated by this process at Kingston.

An important instance of the process of divesting the elm of its outer bark is that of the infested elms along the Avenue Neuilly, the Boulevards, the Quai d'Orsay, etc., in Paris. The barked trees were found to be in more vigour than those in the neighbouring area with the bark untouched. More than 2,000 elms were thus treated.

The Osier and Willow Beetle (*Phratora vitellinae* Kirby).

Information concerning the damage done by Osier Beetles was sought by Liveridge & Co., of Evesham, in May. The beetles sent were the Common Willow Beetle (*Phratora vitellinae*). They were stated to be doing much damage in osier plantations in Worcestershire, especially in the Evesham district.

Another request for information was received in September from Panton, Wragby, Lincolnshire, this beetle was described by Mr. Orwin as damaging the Black Poplars in the estate nurseries. Great numbers also appeared on osiers at Wye, and they were found doing harm in a nursery in Hertfordshire.

This beetle may be met with in all parts of the county on osiers and willows. The beetle is about one-sixth of an inch long, of a beautiful bluish black hue, with metallic lustre above, below it is of a more bronzy-green colour. The wing cases are markedly punctured in rows. It may also be found eating the leaves of the poplars.

The damage done by this beetle is often very severe, and causes much annoyance and loss to osier growers.

The adult beetles eat the leaves and still more damage the valuable rods by attacking their points. The result is that they are stunted, and when the second growth rods are attacked they throw out a number of small, useless lateral shoots and branches, and cease their growth in length.

The larvæ also do considerable harm for they feed together in colonies, and skeletonize the leaves often to a very disastrous state.

Life-history.

The females lay their eggs in masses of from four to thirty on the under side of the leaves. One female I found was capable of depositing as many as twelve batches of eggs, varying in number from four to thirteen.

From these ova the larvæ hatch in a few days.

The larvæ feed beneath the foliage in colonies, often in rows and leave a grey-brown dead skeletonized leaf behind.

The larvæ are dirty yellow in colour, with four prominent brown spots on the dorsum of each segment, head and legs deep brown ; there are also dark lateral spots and on the last two segments a squarish black mark. In length they reach nearly one-third of an inch.

They pupate in the soil, and hatch in autumn. The beetles hibernate under the bark of trees and willows near by, under *débris* on the ground, in the thatch of cottages, in masses of willow shavings or peel, in the hollow stems of herbaceous plants, amongst rubbish brought up by winter floods, amongst the osier peelings used to thatch huts in the beds, and even amongst the shoots of pine trees found growing near.

From these shelters they emerge in spring and lay their grey spindle-shaped eggs, covered with an irregular thin, transparent coating.

Preventive and Remedial Measures.

Since this beetle and its ally (*Phratora vulgatissima* Linn.) have become very troublesome more experience has been gained in dealing with it. The result is we now find that spraying with arsenate of lead is most effectual, not only in

poisoning the larvæ, but also the adults, and it seems to have given general satisfaction.

Spraying with arsenate of lead may then be mainly relied on as a remedy.

An old plan to check the beetle damage was to drag a rope, weighted in the middle, across the osier beds, but this only gave temporary relief.

As far as possible all such places as mentioned as winter quarters should be done away with.

Traps may be laid at the end of the summer to attract the beetles, such as birch bark, heaps of peelings and then burnt in winter.

Flood refuse, that may collect near the beds, should also be collected and burnt before spring.

When small beds are attacked the heads may be brushed by boys, the beetles falling off into a tray of tar.

The Osier Weevil (*Cryptorhynchus lapathi* Linn.).

This destructive Osier Weevil was sent from Harvington, Worcestershire, in February, 1911, with request for information concerning it. The grower, Mr. Hodgkinson, stated that the osier beds had been badly attacked during the past two years, and that the "heads" were dying off. The beetles were attacking the long shanks most and where fresh growths had bushed out at the bottoms, the growth is fairly healthy and free from beetle. The same beetle was said to be found in old ash stocks and other trees.

Some of the osier beds were said to have been practically ruined by them, and other osier growers in the district were also suffering.

The attack of this weevil seems to be rather persistent in Worcestershire. It was recorded in my report for the year ending April 1st, 1909 (p. 84), from the same county.

Nothing further need be added to the account given then.

Dr. MacDougall writing in the *Board of Agriculture Journal* (Vol. xviii., No. 3, p. 214, June 1911) states that this beetle is not common in Scotland and records its food plants as *Alnus glutinosa*, *Alnus incana*, *Salix caprœa*, *S. viminalis*, *S. purpurea* and *S. triandra*, whilst on the Continent itattacks the Alpine Alder (*Alnus viridis*) is attacked.

He advises planting alders here and there in willow plantations to serve as "traps," for this beetle as the alder is willingly and preferably used for brood purposes.

This does not appear to be the case in Kent. I have only once found an alder attacked. Many alders grow close to one of the worst breeding places of *C. lapathi* I know close to my house, but the alders have never been invaded by the weevils and one alder growing amongst them has never shown the least sign of having weevil in or upon it.

The difference in locality, probably accounts for this different preference of food plants. Nothing but cutting back the diseased growths and burning them does any good as far as I have been able to find out.

The Goat Moth (*Cossus ligniperda* Fab.).

On September 17th an inquiry was received from Tankerton concerning the well-known Goat Moth (*Cossus ligniperda*). The correspondent stated that several of the Poplars (*nigra*), Ash trees, etc., in Kingsdown Park, were affected by this pest.

Two elms at Ramsgate were also found in the grounds of the County Council school to be infested with this large larva. The fœtid goat-like smell they produce at times was most marked in the latter case. One tree from which the smell emanated most strongly had no holes in it at all above ground, the larvæ apparently having made them just below the surface of the soil. In such a case it is extremely difficult to apply the cyanide remedy.

The Felted Beech Coccus (*Cryptococcus fagi* Barens.) (Plate XXXV.)

Specimens of this beech pest were received from the Midland Agricultural and Dairy College in May.

The attacked trees were at Mayfield Hall, Ashbourne, Derbyshire. Mr. Haines also received specimens from near Maidstone, and an inquiry was received from West Somerset. Serious damage was being done by this insect, and immediate treatment was advised of spraying with paraffin jelly, and again in winter with caustic soda and paraffin (Woburn Wash).

Several enquiries were also received as to treatment from the Four Oaks Spraying Machine Company, who had been asked to deal with this pest on certain estates.

This treatment I have so often found successful that I now entirely rely upon it.

The Woburn Wash is made as follows :—Soft soap $\frac{1}{2}$-lb. ; paraffin oil, 5 pints ; caustic soda, $2\frac{1}{2}$-lbs. ; water, $9\frac{1}{2}$ gallons.

Dissolve the soap in hot water, churn in the oil and when well mixed shake in the soda and churn, and bring up to 10 gallons with water.

Mr. Pickering's original formula is the one I have found most effective for this pest, and has answered as well as the German preparation I used known as plantol which succeeded so well under Mr. Harold King's employment at Chevening near Sevenoaks.

Plantol can also be used in the summer, but I find paraffin jelly made on the following formula as good : paraffin 5 gallons ; soft soap, 8-lbs.

Boil the soap and paraffin together, and when boiling add one pint of cold water and well stir up the mixture. This becomes a jelly on cooling, and may be stored in pails or boxes. Add 10-lbs. of the jelly to every thirty gallons of water for this insect attack.

The Scotch Fir Chermes (*Pineus pini* Linn.).

Branches of Scotch Fir were received from Woldingham, Surrey, on June 3rd, covered with *Pineus pini* from Mr. E. B. Wimbush. Some hundreds of his trees were affected badly with this disease, and were dying out fast. Other trees such as Austrian Pines, Deodars, Cupressus had escaped, but the Weymouth Pines were badly affected.

The species, however, on the Weymouth Pines was probably distinct.

The Chermes on the Scotch Fir (*Pinus sylvestris*) is *Pineus pini*, formerly called *Chermes pini*. It infests the branches and shoots and needles, forming white woolly nests shown in the photograph reproduced here (Plate XXXVI.).The Scotch Fir is the intermediary host plant, the primary hosts are *Picea excelsa* and *Picea orientalis*, where this aphis forms rather obscure galls.

A bad attack also took place on some nursery stock at Wye in 1911, the young trees being quite covered as seen in the photograph.

Some badly attacked young Scots Fir were treated with paraffin emulsion at Widdington Herts, and soon cleared the pest off.

When young trees are attacked, if nothing is done to them they soon die right back. In older trees I have often seen the young shoots, bent and twisted and dying from the constant sucking of these aphides.

The females may be found in late April on *Pinus*, brown in colour with scanty woolly covering. In May I have found them depositing eggs, stalked as in other Chermes, the eggs forming an olive coloured mass over the female's body. In a few days these hatch into little active larvæ, which wander over the needles, and soon commence to produce white, silky filaments.

In nursery stock it is easily controlled by spraying with paraffin emulsion.

Mr. Jemmett treated the College trees with MacDougall's summer wash, and a single spraying cleared them of it, and the attack was a very heavy one.

Other Forest Tree Pests.

Aphis abietana Walker attacking dwarf Abies at Worksop.

The Wood Wasp (*Paururus noctilia* Fab.) from Messrs. W. Moss & Co., on September 19th, found in wood just sawn up for use.

ANIMALS INJURIOUS TO MAN.

House Flies.

A request was received from General Sir Reginald Hart, V.C., K.C.B., Commander-in-Chief of the army in South Africa, for information concerning the habits of the House Fly and its allies, and for any means that can be taken to lessen the evil in South Africa. The following report was sent.

General Hart replied that he was having it printed and distributed amongst the troops.

Report on the Destruction and Prevention of House Flies.

The evidence is now conclusive that flies, especially the cosmopolitan House Fly (*Musca domestica* Linn.), are one of the most important agents in disseminating Typhoid Fever and Cholera.

It is also regarded as certain that house flies convey the causative agents of infantile or summer diarrhœa and dysentery.

Besides other disease germs they are also known to distribute the ova of such human parasitic worms as Tapeworms (*Taenia solium*) and white worms (*Oxyuris* and *Ascaris*). The germ of tuberculosis, etc., may also be distributed by fly agency. They are also supposed to play an important part in spreading infectious ophthalmia in Egypt.

The House Fly (*Musca domestica*) and some other species found with it deposit their eggs on all manner of defæcated animal matter including human fæces. Horse manure is especially chosen. Whilst depositing their ova, and when absorbing the moisture of fæces, their bristly legs, feet and mouths become covered with germs. They fly off to man's habitations and feed upon sugar, meat, milk, fruit and leave

these germs behind them. The bacilli may also pass through their bodies, and be ejected in the fly marks as virulent organisms. They also fly to patients suffering from typhoid, etc.

Three observations in connection with the British Army in South Africa during the late war may be quoted here.

Tooth and Calverley write as follows: "In a tent full of men all apparently ill, one may pick out the enteric cases by the masses of flies that they attract."

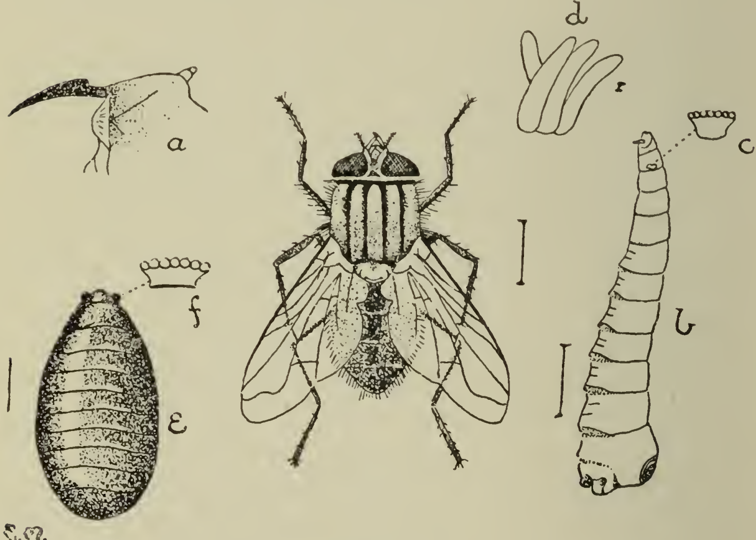


Fig. 11.

The House Fly (*Musca domestica* Linn.)

a. head of larva; *b*. larva; *d*. ova; *e*. puparium; *c*. and *f*. spiracles.

On the Modder River it was noticed they passed over men suffering from sunstroke and at once settled on the tongues of men with enteric.

They may thus carry the disease direct from man to man's food and drink.

F. Smith writes *re* South Africa that "every neglected trench becomes an open privy with an infected surface soil around it, the flies browse in it in the day time, and occupy the men's tents at night. On visiting a deserted camp during the recent campaign it was common to find half a dozen or

so open latrines containing a mass of fetid excreta and maggots. This was due to the responsible persons failing to comply with the regulations for encampments." It may be noted here that the flies coming from maggots which have fed on infected fæces can carry the disease germs in their bodies.

Thirdly Austen records a camp in South Africa during the war " with an open latrine, only a hundred yards from the tents, a seething mass of flies. A tin of jam incautiously left open for a few minutes became a seething mass of flies completely covering the contents."

The Life Cycle of the House Fly may be very rapid. In warm climates and during the warm parts of the year in temperate climates the whole development may only take eight or nine days.

The female lays her eggs in batches of from 100 to 150 ; each female laying as many as six batches during her life. The eggs hatch in from eight to twenty-four hours into white footless maggots. The maggots pass through three stages, the last stage being the longest. This condition lasts about five days ; when maturing the larvæ are nearly half an inch long. They then become reddish brown puparia, a little more than one-fourth of an inch long and hatch into flies in three days.

Breeding Places of the House Fly.

The chief breeding place of the common House Fly is horse manure. They also swarm in human fæces, both when in masses in latrines and pits and even when isolated. Cow dung and poultry dung may also harbour them. Kitchen refuse, dustbins, ashpits, material fouled by excrement such as old bedding and paper, spent hops, moist privy matter and in fact all animal and vegetable decaying matter may harbour the grubs. Horse dung and human excrement in masses are the main centres. Moisture and fermentation are necessary for the proper and hasty development of the maggots.

Prevention of House Flies.

Horse manure should be removed from near barracks, camps and dwellings houses by every *sixth* day. It should be removed away as far as possible, not less than one mile, and

now and then covered with chloride of lime. It is best to store it even for a few days in closed receptacles.

2. Latrines should be made as far as possible from quarters and should be covered with soil every few days, given a heavy dressing of chloride of lime.

3. Kitchen and all other refuse should be burnt at once or kept in closed receptacles, and now and then covered with chloride of lime.

4. General refuse should not be shot in "tips" nearer than one mile from camps and towns, and if possible "tips" should not be allowed if the refuse can be burnt.

5. Hospitals, especially where there are infectious cases, should have windows and doors screened with wire gauze, and mess rooms and tents also where possible should be protected.

6. Food especially sugar, meat, fruits and milk should be kept under muslin.

7. When great numbers occur in barracks, huts, etc., they may easily be killed by fumigating with pyrethrum.

The main thing to aim at is the destruction of breeding grounds.

It might be advisable to issue a simple leaflet of instructions such as the one appended.

LEAFLET.

Instructions for Destroying House Flies.

The great danger of House Flies carrying on their feet, legs, mouth, etc., the germs of typhoid fever, cholera, summer diarrhœa, etc., and the eggs of parasitic worms from filth and refuse where they lay their eggs to man *via* his food and drink is now an established fact. Thousands of lives are annually lost through the Typhoid or House Fly. The ways to prevent this grave danger are two-fold.

a. Destroy the Breeding Grounds.

The eggs are laid in horse manure, house and kitchen refuse, human excrement and soiled substances, also decaying vegetation.

1. All stable manure should be kept in closed receptacles, and must be removed by every sixth day to at least one mile

from barracks and camps, and should be now and then sprinkled with chloride of lime.

2. All latrines should be as far as possible from mess rooms and tents and hospitals. They should be covered with soil every day, twice if possible, and every few days dressed with chloride of lime.

3. All kitchen and household refuse should be burnt at once or buried in pits, and at once covered with soil or treated with chloride of lime and burnt every sixth day.

b. Protection from Flies.

1. Food, especially milk, sugar and fruit, should be kept screened with muslin when house flies are about.

2. Mess rooms (and tents if possible) should have doors and windows screened with fine wire gauze during the fly season.

3. Hospitals, especially where infectious cases are present, should have window screens or sun blinds.

Flies when present in numbers in buildings may be cleared by burning pyrethrum.

All possible steps should be taken to prevent them contaminating man's food, from breeding in human excrement and from entering hospitals.

ANIMALS INJURIOUS TO MAN'S BUILDINGS, FURNITURE, STORES AND FOOD.

Insects (*Ptinus fur* Linn. and *Niptus hololeucus* Fald.) attacking Dried Hops.

A sample of hops was received attacked by beetles in May. A note was given on a beetle (*Ptinus fur*) in connection with hops in my Annual Report for the year ending April 1st, 1909, p. 66.

This beetle was mentioned by Mr. Richardson as becoming of late rather a serious pest in the Borough amongst old hops.

In another lot of hop samples sent I also found numbers of another beetle known as *Niptus hololeucus*.

As many of the warehouses are old ones, there is some doubt if fumigation would be effective, even after the hops are cleared out. Samples of 1907 hops were forwarded, showing the damage done. One of these has been reproduced here, showing the holes eaten into and out of the hops, by the beetles. (Plate XXXVII.)

The first received species *Ptinus fur* is common, and generally distributed over Britain. It is found in houses, museums, stores, warehouses and sheds, and occurs in old wood. It has also been found in birds' nests. It has been recorded as feeding on grain, on old clothing and on museum specimens. It appears that both vegetable and dead animal matter are alike eaten by it and its larvæ. The larvæ are fleshy grubs, white to creamy white in colour, and are usually curved, the head is brown and the body footless, the abdomen being composed of nine segments and terminates in a single rounded end.

The female beetle is about one-eighth of an inch long, the male slightly longer, in colour the female varies from light to dark brown, the thorax having two lines of yellowish grey hairs one on each side of a central furrow ; on the wing cases are two bands, more or less complete, of a whitish colour, but these disappear in old rubbed specimens.

The male is longer and narrower than the female and the antennæ are longer, so are also the legs.

The second species (*Niptus hololeucus*) is also frequently found in old houses, stores, granaries, malt houses, etc. It likewise is now generally distributed over the country, and has spread from the towns to even the remotest country villages.

This beetle is frequently found in cupboards and storerooms. It is not a wood borer in any of its stages. It has often been noticed in silver cups and tankards.

In appearance it is quite different to the former. In form it is globular and covered with a silky golden brown pubescence ; there are no wings and only very small eyes. In size it varies from one-eighth to one-sixth of an inch. The larvae are very similar to those of the former beetle. It lives in colonies in dark places, under the floors, amongst dry rubbish and in the materials that it attacks.

From all we know it seems to have been an imported insect, and to have gradually been spread over the country artificially.

It is extremely difficult to get rid off, owing to its living in all manner of out of the way places, frequently sheltering deep in crevices in old walls and in the flooring.

The beetles of both kinds were found breeding freely in the hop samples sent, the larvæ reducing the samples inside in places to a powder.

Fumigation has not proved successful for them, owing to their sheltering habits and in warehouses it seems that the best treatment is to attack them by thoroughly cleaning out, applying where possible steam at great pressure to all crevices, and then lime-washing down all walls, adding to the lime-wash paraffin, after the removal of all attacked material.

It does not seem to be attacked by any natural enemies.

Niptus hololeucus infesting a House.

A house in a Gloucestershire village was invaded by the beetle *Niptus hololeucus*. As the owner was anxious to have the beetle cleared out it was decided to fumigate the whole house with hydrocyanic acid gas.

Mr. Walter Voss undertook this somewhat dangerous work.

Not only the house but the adjoining stables and outhouses were also fumigated.

The house was so completely sealed up that no trace of the fumes could be detected outside.

The first fumigation was done on the night of June 18th, and the house was opened mid-day of the 19th. Part of an adjoining house where the beetles had also been found was also fumigated. The result of this treatment was that out of 400 beetles collected next day 4 per cent. were alive, 8 per cent. lively, but *hors de combat*, and 88 per cent. dead.

The beetles *hors de combat* had in all cases their hind legs paralyzed and could only just drag themselves along, others kept rolling on to their backs.

The following is Mr. Voss' Report :—

Report on Fumigation of House with Hydrocyanic Acid.

Material used per 1,000 cubic feet: sodium cyanide, 8-ozs ; sulphuric acid 1.840, 16-ozs. ; water, 24-ozs. The house was first carefully stopped ; windows, outer doors and keyholes were sealed with paste and paper, and the chimneys were filled up with bags of hay tightly fitting, and the tops with sacks wedged in. Materials were spread so that each room had its own complement, although the doors inside were left open so as to equalize effects, except in the case of one part, termed the brushing room, with an adjoining passage. This had a galvanized iron roof, and although the open spaces at the lower part of the corrogation, where this rested, were stuffed with hay as well as possible, it was thought desirable not to weaken the effect through the whole house by any loss that might occur here, so that this room and passage were separately closed away, with the assistance of paper and paste, from the rest of the house. In this part, however, the effect seemed to be satisfactory.

The house was opened twenty-four hours after cyaniding, except the chimney stops, which were left for a further six hours.

Entry was effected into the house about five hours after the first opening, and consequently one hour before the chim-

neys had been unstuffed. Large numbers of the particular dead insects for which the fumigation was instituted, together with various others and other allied forms of life, were found spread about the floors and other part of the house. A few of the particular insects, namely *Niptus hololeucus*, were found crawling upon the walls and floor. A larger number were found injured, a large proportion of them being capable only of making an occasional movement of one limb at a time. A collection was made of all that could be found of these two last, together with what could be picked up of dead insects during the same period. When upwards of 400 had been examined, the result showed about 4 per cent. alive and active, 8 per cent. seriously injured or nearly dead and 88 per cent. quite dead, so far as any intimation of life could be found, during several examinations that we made at intervals after they had been placed near a current of fresh air. Of the alive and active several died after capture, while on the other hand some that showed only slight movements more or less recovered, although of these the majority, two days after the opening of the house, have their hind limbs paralyzed, while others which appear to have recovered, while standing on their feet, with the slightest excuse or in any cases without any excuse whatever, roll over on to their backs, apparently unable to keep the right way up.

As some beetles remained a second fumigation was given in the second week in July and the house left closed for ninety-six hours.

The amounts used were double the strength of the former fumigation and the results as stated below.

Report on the Second Fumigation of the House.

The house was closed and other precautions taken as in the case of the first operation, in addition to which two boards in each room on opposite sides were taken up, so as to exposed the floor space below and permit the circulation of the fumes underneath the flooring boards.

The materials and proportions used on this occasion were for each 1,000 cubic feet.:—16-ozs. sodium cyanide; 21 ozs. sulphuric acid 1.840; 28 ozs. water.

The fumigation was commenced and the house closed at

1 p.m. on Saturday 8th July, and was re-opened on Wednesday, July 12th at 4 p.m., and entered about four to five hours afterwards, using the same precautions referred to in the previous report.

The quantity of gas emanating from the freshly-opened windows and doors appeared to be quite as much or more than that found on the previous occasion, when half the quantity of cyanide was used, but then the house was only closed for about twenty-four hours. (The general opinion of those concerned in the opening was that it was stronger.)

On examination soon after entrance a few insects were found alive coming from, or in proximity to the windows and doors, and a few more were found the next morning. The number of dead, however, was considerable, 327 being counted in the space underneath the opening where one flooring board had been raised. It therefore appears that if the insects found were in the house at the time of the fumigation, they could only represent a very small fraction of a percentage of those killed.

One point was very obvious, however, in which those living insects found varied from those discovered on the previous occasion. It was that where they were found alive, practically in all cases they appeared to be uninjured, except in the case of one or two that were apparently mechanically injured in capture. There were no symptoms of paralysis such as those discovered previously, nor were there any cases of them being found with just a trifling amount of life and capacity of movement, that is to say, those that were not apparently quite alive and healthy were absolutely dead.

One point that stood out somewhat prominently in connection with this operation was the long and effective retention of the gas in the house. It was obvious that a very much longer period could have been given, had it been felt desirable, during which the gas could have been effective.

A further point of difference was noted, namely, that the retention of the gas by mechanical occlusion was evidently considerable. Although the house was entered late on the evening of July 12th, the following morning, after the closing up of the lower windows for the night, and also on the second morning, after all windows and doors being opened during the

previous day and a similar closing of the lower part of the house for the night, it was impossible to re-enter the house to re-open the lower windows for something like an hour after opening the doors.

WALTER A. VOSS, F.C.S.

It will thus be seen that this powerful gas is not completely effective in killing the *Niptus* and so cannot be relied upon. Great numbers were killed, other insects such as the furniture beetles, flies, roaches, etc., were all dead, but the chief pest was not eradicated and still occurs in small numbers.

Soya Beans attacked by *Bruchidae.*

A sample of Soya beans of two varieties, namely pale green, yellow inside, and pale yellow, yellow inside, received from Wei-Hai-Wei by the Director of the Imperial Institute were forwarded to the College in December.

They were found to have been attacked by a species of *Bruchus* which were, however, too damaged to identify. The sender of the beans stated that the grub appears only in the two varieties of beans which he sent, and that its presence cannot be detected at all from the outside.

This latter observation is of interest as in beans, peas and many forms of gram and tropical pulse the presence of the pest, when in pupal stage anyway, can be detected by the round depression in the seed (Plate XXV. C).

The Cork Moth (*Oinophila v-flava* Haw.).

This now well known cork pest was sent in March, 1911, in the larval stage from London, with the note that it was doing damage to bottled wines, and that in the trade it is known as the "Weevil." The larvæ were found in the corks of port bottled three or four years.

The Moth, it was said, lays her eggs on the sweetness always left round the edge of the cork and the bottle. Very rarely do they attack dry wines.

No further reference need be made as this pest was dealt with in the last report, pp. 134-136.

Corn Weevils (*Calandra granaria* Linn.).

Information was sought again from the Imperial Institute in regards to Corn Weevils attacking crops in the field. It is now well known that in Southern Nigeria this serious corn pest attacks the growing grain. Mr. C. Jemmett, late Government Entomologist of Southern Nigeria, found it in abundance in the fields and that little could be done with the native farmers in this respect.

An inquiry for information on this corn pest was also sent from Blackheath Park and elsewhere. As there have been so many inquiries for the original article on this pest I prepared with the help of the late Mr. Kains Jackson, when I was at Cambridge, it is hoped to have it re-issued, with the many new facts that have since come to light in the next Annual Report.

The Tobacco and Cigarette Beetle (*Lasioderma serricorne* Fab.)

A request for information concerning the destruction, prevention and life history of this beetle has been received from Malta.

The correspondent stated that this "nuisance, to which Turkish leaf tobacco is liable is a source of great anxiety and loss to all Egyptian cigarette manufacturers. As you will see from the enclosed samples of tobacco leaves, eggs of certain species of insects are to be found, which during the hot months of June, July, August and September in warm climates like Turkey, Eygpt and ours hatch into a sort of whitish maggot, which bores the cigarette paper, as per samples sent. A remedy is very imperatively demanded, because under present circumstances it is not only hazardous but quite impossible to export cigarettes to tropical countries. Moreover, this year, on account of the abnormal heat which has prevailed all over Europe, we have received also from continental countries reports of the apparition of these maggots which have spoiled the cigarettes, through the holes which have been bored through them."

An examination of the leaves sent showed how serious the damage had been, the leaves being eaten away until many were mere fragments.

Instead of finding any larvæ and beetles of the Cigarette Beetle (*Lasioderma serricorne*) I found a number of the much larger Cadelle (*Trogosites mauritanicus* Linn.) and their larvæ.

Not feeling satisfied that these were the cause of damage to the leaves, I wrote for more material. The cigarettes, however, had without doubt been attacked by the *Lasioderma.*

A fresh supply of leaves were soon sent. This yielded maggots of the true culprit in numbers. The live Cadelles and their larvæ were kept in the meanwhile with undamaged leaves, and as far as I could see during the two weeks they were kept with them the beetles did no harm, but the larvæ appeared to have eaten some of the leaf.

Knowing that the Cadelle is not only found damaging stored articles but that it is also insectivorous I placed some *Lasioderma* larvæ with them, in a very short time the Cadelles both larvæ and adults, had devoured them.

It thus appears that this beetle is beneficial, in any case it will go on feeding on the Cigarette Beetle larvæ and pupæ as long as they are present. Whether they would do any serious damage to the leaves after their normal food had all gone or not could not be definitely settled, but from the very small amount of damage done in two weeks by them to the sound leaves it appears that they cannot be very harmful. Advise was sent to try the same methods that I adopted in treating a factory and bond in London with success.

The methods suggested were fumigation with pyrethrum, the application of steam to the tobacco leaf, steaming under great pressure the crevices and corners in the stores after they were well cleaned out, and last, fumigation with disulphide of carbon, the latter, however, was not pressed owing to the danger of using it.

A report was sent later saying the recommendations had been carried out, except the use of the disulphide of carbon which the manager agreed was too dangerous to use in such large buildings.

The report says " We made an experiment of fumigation by pyrethrum which although it killed all the *Lasioderma serricorne,* only stunned the *Trogosites mauritanicus.* The flavour of the tobacco, however, was very much affected by

the smell of the pyrethrum. For this reason, therefore, we found it impossible to adopt this means of disinfection.

"We were fortunate, however, in our trial of disinfection by steam, because after three minutes exposure, both insects were killed whilst the tobacco has not been affected at all. No doubt the delicate ova are killed as well. Could you kindly clear us on this point ?

"We have therefore, adopted this method of disinfecting for both the tobacco as well as for all the stores where the tobacco is kept or manipulated."

As previously stated, I found that the three minute steam treatment destroyed the ova completely. An account of the life history of the Cigarette Beetle was given in my last Report.*

The presence of the Cadelle and the good it was doing is interesting, also the fact that whilst Pyrethrum was fatal to the *Lasioderma* it was not to the *Trogosites.*

Life History of the Cadelle (*Trogosites mauritanicus* Linn.).

The beetle is black and flattened in form, elongated and about one third of an inch long. There is only one brood a year. It is found in most countries, having been distributed in stores, etc., from place to place. The larva is active, fleshy and slender, of a dirty white colour, with a prominent dark brown head and dark markings on the first three segments, the tail is also dark and terminates in two dark points, on the first three segments (*thoracic*) are three pairs of brown legs and the body is slightly hairy. When full grown, they may be nearly half an inch in length. The pupa is dull white. The beetles and larvæ undoubtedly are predaceous, but as pointed out, may, under stress of circumstances, feed on dried vegetable matter.

Slingerland† has also found that both larvæ and adults are granivorous and that they devour the embryo germ, going from kernel to kernel.

* Report on Economic Zoology for the year ending September 30th, 1910, pp. 132-134.

† "Some Insects Injurious to Stored Grain," p. 18-19. *Farmers' Bulletin*, No. 45. U. S. Dep. Agriculture, 1896.

An Ichneumon Enemy of the Mediterranean Flour Moth (*Ephestia kuhniella*).

Mr. W. W. Froggatt, Government Entomologist of New South Wales wrote me in July asking if I knew anything concerning a circular sent him giving an account of an enemy of the very harmful and widely spread Mediterranean Flour Moth (*Ephestia kühniella*).

I at once got into communciation with the writers of the article, the owners of the well known King Flour Mills, at Ellesmere Port, who at once sent me the following letter published in *Milling* for May 13th, 1911.

" The Mediterranean Flour Moth.

A Novel Discovery.

" Sir,

" In one of your contemporaries for Wednesday, September 11th, 1895, an article appeared on the Mediterranean Flour Moth (*Ephestia kühniella*) written by Mr. Gerald McCarthy. A cure for this pest was fully described and it was shown that a free distribution of Carbon Bisulphide in shallow pans gave off fumes of poisonous gas which killed all the moths and larvæ that happened to be in the vicinity. The method was tried by many millers and whilst it gave temporary relief by killing all insect life, it did not have any effect on the ova and there was very soon a recurrence of the trouble.

We believe that we have made a discovery which will perpetually keep in check the moth evil, and so greatly minimise the number of chokes in a mill from this cause. We have introduced and are successfully breeding an ichneumon fly—which lays eggs in the larvæ of the moth. When these maggots are in the chrysalis stage, the ichneumon eggs hatch out, feed on the living tissues and instead of moths emerging, ichneumon flies appear. The flies are in no way a nuisance to the miller, and their numbers are regulated by the supply of larvæ, this latter, naturally, being constantly reduced.

The ichneumon flies have been active in our mill for about twelve months, and having passed through the winter seem quite acclimatized. The mill is practically clear of moth

cocoons which used to so rapidly block up the spouts, and chokes from this source are now rare indeed.

"Yours, etc.,

"R. C. Ingleby.

"King Flour Mills,
"Ellesmere Port,
"*May* 10*th*, 1911."

The owners kindly wrote me saying that they had supplied several millers with ichneumons and impregnated larvæ, and that they found that a few millers had these flies, but were destroying them, and that owing to the scarcity of moths in their mill at present they were unable to supply any ichneumons. They also informed me that they had sent a supply of impregnated larvæ to a miller in South Africa.

Later they kindly sent me specimens of the ichneumon, with a note that they did not know what they fed upon, nor how many eggs the female laid, but they found that only one ichneumon hatched from each moth pupa.

They had tried to breed the ichneumon upon other larvæ than those of the Ephestia, but up to now have failed.

A number of males and females were sent me, and these Mr. Claude Morley has identified as *Olesicampa flaviventris*. (Plate XXX. B.)

Other Household and Store Pests.

Cachou nuts attacked by *Tribolium ferrugineum* from London.

Almonds attacked by *Ptinus lectus* from Cheshire.

Ants (*Monomorium pharoensis*) attacking a bakery in Glasgow and a house in Westminster were also enquired after. In the latter case this little Red Ant had become a veritable plague. It first appeared in September in the kitchens and servants hall, and later worked its way upstairs.

With care the nests can be located in some hole near a fire place or hot water pipes. Nothing can be done except to trace out their nesting quarters and then either sulphur fumes or tobacco smoke must be injected with force into the crevices where boarding, etc., cannot be removed.

Mites (*Glyciphagus longior* Gerv.) infesting a House.

From Littleborough, Lancashire, information was sought concerning the mite called *Glyciphagus longior* Gerv. (Plate XXXIII. A.), which had invaded a house in great numbers and caused much annoyance and inconvenience.

Everything that could possibly be removed from the house had been sent away and fumigated with sulphur, and the house also. This is at present the only known treatment for this mite.

UNCLASSIFIED.

Enchytraeid Worms.

Many enquiries have been made concerning these white worms, which are parasitic on the roots of plants. They can at once be told under the microscope by the bristles or setæ being in groups.

Great quantities were sent from West Malling in February, the soil of tomato houses and borders being full of them. Others were sent from chrysanthemum roots from Suckley.

They were also found attacking hop roots at Paddock Wood. The Fuggles were especially attacked, and they were not so noticeable in other sorts.

Being free in the soil they are easily destroyed.

Lime if worked into the soil warm and finely powdered was found to kill many.

Numbers were placed in a large pot with fine roots and then one part of powdered vaporite to ten of fine soil was worked into the pot to a depth of four inches. In half an hour all the worms were dead.

Similar results were obtained in a garden border where the worms were in great abundance. Any of the soil disinfectants on the market will kill them.

Shower or Mermis Worms.

Numbers of these parasitic worms were received from correspondents in 1911.

Mr. H. Boshier, of the Horticultural Mutual Improvement Society of Croydon and district found them in great numbers in June in his garden creeping about in a very lively condition following a good rain during the night.

These long, thread-like worms live as parasites in the bodies of insects. The sexual form lives in damp earth, and

after storms and heavy showers may often be found in great numbers crawling up plants. The female lays her eggs in the ground, and there they hatch into larval worms. These larvæ then invade grasshoppers, caterpillars, chafer larvæ etc.

Mermis nigrescens Duj. lives in grasshoppers, *M. albicans* v. Siet in caterpillars. The larvæ of the last-named have been observed boring their way into small caterpillars through their skin. There are many more of the family Mermithida which are parasitic in beetles and flies.

One called *Allantonema mirabile* is often common in the Pine Beetle *Hylobius pini*, another *A. diplogaster* in the Bark Beetle *Tomicus typographicus*. Another is parasitic in the species of Bumble Bees (*Bombus*) called *Sphaerularia bombi*.

The presence of this parasite affects the reproductive organs of the bees so much so that an infected queen never succeeds in forming a colony.

Centipedes (*Polyxenus sp.*) on Fruit Trees.

Great numbers of a small and curious centipede belonging to the genus *Polyxenus* were found by Mr. Blackburn of Hoo, Minster, Ramsgate, in December, sheltering under the bark of apple trees and pear trees in his orchards. These creatures have very short legs, and are protected by bundles of bristles.

They appear to feed on decaying substances under the bark.

Beetle Mites (*Oribatidae*).

Large numbers of these acari appeared again last year. Quantities of them were forwarded in May from the Limpsfield and District Gardeners Mutual Improvement Society.

At the same time others came from Oxted, were they were reported as occurring in thousands on the bark of plum and pear trees. Some growers are washing to destroy these beneficial acari !

Psocid Eggs.

Numbers of these eggs were sent in February by Mr. B. Blackburn, from Minster. They were found in abundance on most of the apples usually situated underneath the junction of the various branches. They are harmless.

Slugs on Trifolium.

In September the following communication with request for information was received : " My trifolium is just showing itself on twelve acres of oat gratten and now millions of slugs, large and small, both black and white, are all over it."

Information was sent regarding their life habits, and either basic slag alone or vaporite one part and basic slag ten parts was advised on a top dressing. Both these I found most successful in one case. The basic slag alone was decided on.

Lady Bird abundant upon *Euonymus.*

From Jersey a communication was received in September concerning the abundance of a ladybird beetle, which proved to be *Thea vigintiduo-punctata,* upon euonymus on the island, particularly on those affected with mildew. Mr. John Dunlop, who forwarded the beetles, said he could find no aphis at all on the euonymus, and it was wondered if the beetles were feeding on the mildew fungus. There does not appear to be any record of such a habit amongst the Coccinellidæ, although many, especially the genus Epilachna, feed upon vegetation. These vegetal feeders have hairy bodies, and can thus be at once distinguished from the Aphis and Scale Feeders.

Ichneumon Parasities.

The following have been identified by Mr. Claude Morley :—

Bred from *Emphytus cinctus* several *Limnerium* sp. ? Hereford.

Bred from *Nematus ribesii* many *Perilissus naevius* Gmel, Wye.

Bred from *Pissodes notatus* one female *Ephiates tuberculatus* Foure—a small female. The small size is due, probably, to the fact that the specimen was bred from material kept in a dry place for some months, Alnwick, Northumberland.

Swarms of Aptera (*Lipura ambulans* Linn.)

The aptera frequently appear in vast numbers, such a case was reported on March 24th by Miss E. Malden, of the

National Fruitgrowers' Federation from Crawley, Winchester. She wrote that she found millions of these insects floating in masses on the top of puddles of rain all along the edges of the garden paths under a row of large Blenheim Orange apples. As they floated on the water they were observed to hop and skip about with great agility. They were all sprayed with strong H. Emulsion and soon killed.

The species proved to be *Lipura ambulans* Linnaeus.

This white springtail frequently damages the roots of plants, such as peas, beans, cauliflowers, seakale and asparagus, etc.* It is possibly this species which causes so much annoyance under glass in Guernsey.

Bettles attacking Sugar Cane.

The Imperial Institute wrote for information concerning the beetle *Podisthus agenor* Burm, said to be damaging sugar cane in Central America, its large larvæ doing, it is said, considerable damage.

San Jose Scale (*Aspidiotus perniciosus* Comst).

An inquiry regarding this Coccid scheduled, by the Board of Agriculture as a notifiable insect was received from Mr. S. C. Davidson, of Belfast. A pamphlet upon it was sent.

Phytonemus murinus Fabricius.

Information concerning this insect was sought from Utah, U.S.A., it having been introduced into that State.

Enquiry *re* Degeneracy of Fish.

A communication was received from the Secretary of the Hastings Waltonian Society regarding the degeneracy of fish in the preserved waters of the Society in the Military Canal near Hythe.

As the water was known, advice regarding the management of the weed and the breeding places of the Bream and other fish was sent.

* Springtails (Collembola). Their Economic Importance, with notes on some unrecorded instances of damage. Memoires, 1st Int. Cong. Entomo., p. 10, Vol. II., F.V.T.

Maggots in Tobacco in Rhodesia.

Some maggots found attacking tobacco in Rhodesia were sent from the Imperial Institute. They were weevil larvæ, but no one could identify them.

How to keep out Cats from Gardens.

An inquiry was received from the Central Chamber of Agriculture as to how cats can be kept from their too frequent peregrinations and philanderings in suburban gardens when they often do much damage. Tanglefoot was suggested, and I tried this and found that a cat would not cross over it. It might therefore be placed along the wall tops and at the same time serve other purposes.

Report on Locusts in Cyprus.

An enquiry was received from the Imperial Institute concerning measures to be taken to cope with the locust plague in Cyprus. The following report was sent :—

Five species of locusts were sent in the collection that could be identified namely :—*Pachytylus nigrofasciatus* De Geer, *Bryodema tuberculata* Fabricius, *Schistocera peregrina* Oliv., *Drymadura spectabilis* Stein, *Schingonatus azurescens* Ramb.

The numbers attached are as follows : 1. *P. nigrofasciatus* ; 2, 3, 4 and 6, *Bryodema tuberculata ;* 5, *S, peregrina* ; 10 and 5*B*, *Drymadura spectabilis ;* 11 and 12, *S. azurescens.*

There may have been others amongst the dried specimens but they were in such bad condition they could not be identified.

Prevention and Remedies.

The following are the more important methods followed to destroy locusts and prevent their appearance :—

(*a*) *Destruction of Eggs.*—The pods which are usually laid in firm ground may be turned up and exposed by loosening the soil to a depth of three inches—this exposes them to the attack of birds and parasites.

Egg masses may be collected by hand where labour is plentiful. This has already been done in Cyprus, so need not be further referred to.

(*b*) *Catching and driving the insects.*—On a small scale this may be done, either by catching the " hoppers " in special machines (" hopper dozers ") as used in America, or by driving the insects into ditches or traps as has been already done in Cyprus.

(*c*) *Poison Spraying and Baits.*—This is by far the best method of fighting locust plagues, and the chief method adopted in Africa. The poison used is as follows :—arsenate of soda, 1-lb. ; sugar or treacle, 2-4-lbs. ; water, 16 gallons. This may either be sprayed with ordinary spraying machines over the grass, etc., where the locusts are moving, either in front of them or in a circle around them in a fine mist over the vegetation they are eating, or

Green stuff (grass, lucerne, etc.) may be heavily sprayed, and then cut and put about as baits to attract the locusts. They readily make for the treacle or sugar, and die in a day or so after at the most.

(*d*) *Burning.*—If the vegetation the hoppers are in is sufficiently dry they may be destroyed by burning it, especially if in grass.

(*e*) *Locust Eating Birds.*—Many birds, especially storks (*Ciconia*), are of the greatest use in keeping them down and should be encouraged.

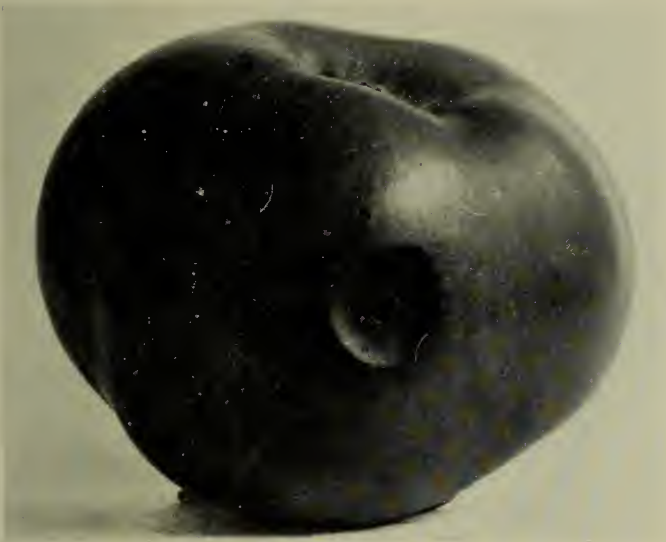
The Guinea Fowl is also a great locust enemy and might well be encouraged in the island. So also are turkeys.

All locust-eating birds should be protected by legislation. Kestrels (*Tinnunculus*) and Kites (*Milvus*) also feed on them.

(*f*) *Locust Fungus.*—The African Locust Fungus (*Empusa gryllus*) does not appear to have met with any such success that would allow suggesting it as a remedy.

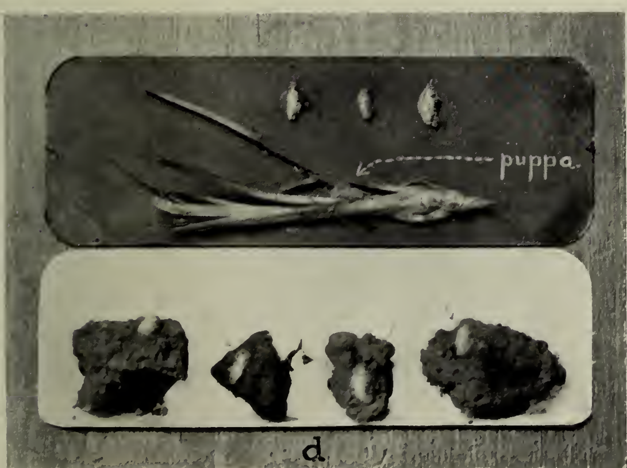
Summary.—All one can do to meet with success is to use poisoned baits or poison spraying, and to encourage all locust eating birds.

PLATE I.



Apples showing early damage caused by second brood of Codling Moth.

PLATE II.



Argyresthia conjugella. Zeller. a. Adult, natural size and enlarged; b. Larva; c. Damaged Apples; d. Cocoons. (Original figures by Professor Tullgren.)

Plate III.

A.

B.

Apples attacked by *Argyresthia conjugella.* Zeller. A. Early stage; B. Late stage.

PLATE IV.

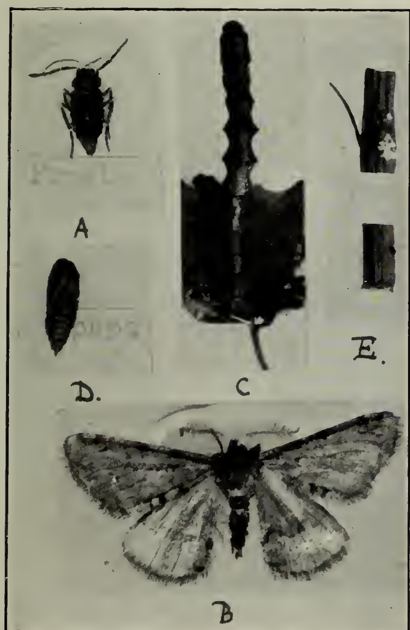
A.

C.

B.

A. Currant Shoot attacked by *Spilonota roborana* Tr.
B. Female *Chimabacche fagella* Fl.
C. *Hypena punctata* Fab.

Plate V



[*F. Edenden.*

The Pale Brindled Beauty
(*Phigalia pilosaria* Hb.)

A. Female; B. Male; C. Larva;
D. Pupa; E. Ova.

Apple blossoms damaged by the Raspberry Beetle (*Byturus tomentosus* Fab.).

Plate VII.

[*F. Edenden.*

Damage done to Apple Shoot by Green Bugs and Yellow Springtails.

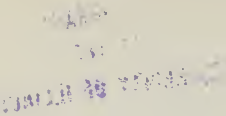
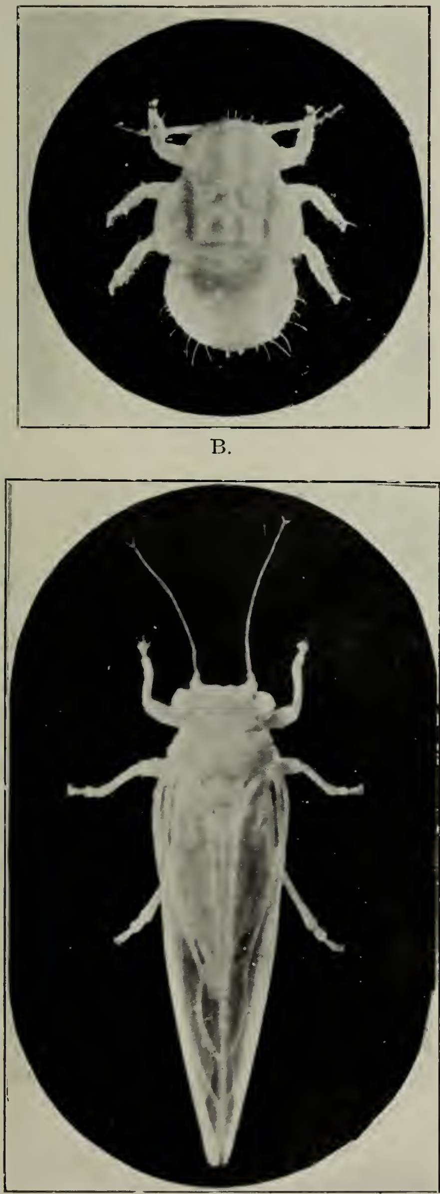


Plate VIII.

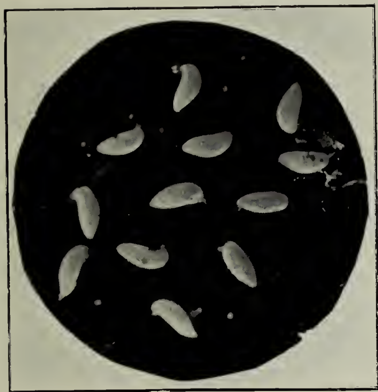


B.

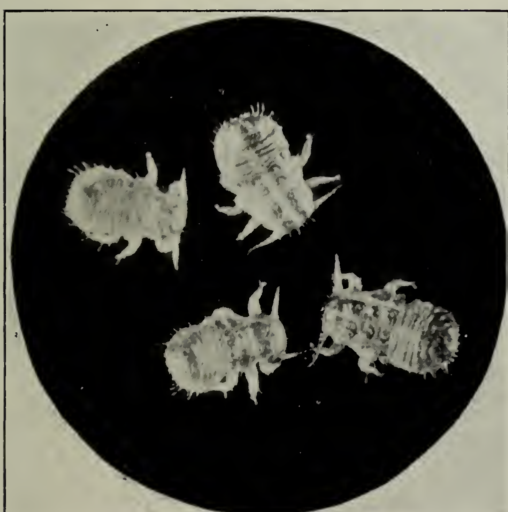
A. [*J. G. Blakey.*

Adult × 16 (A) and Nymph × 26 (B) of the Apple Sucker (*Psylla mali* Sch.).

Plate IX.



A.



[J. G. Blakey.

B.

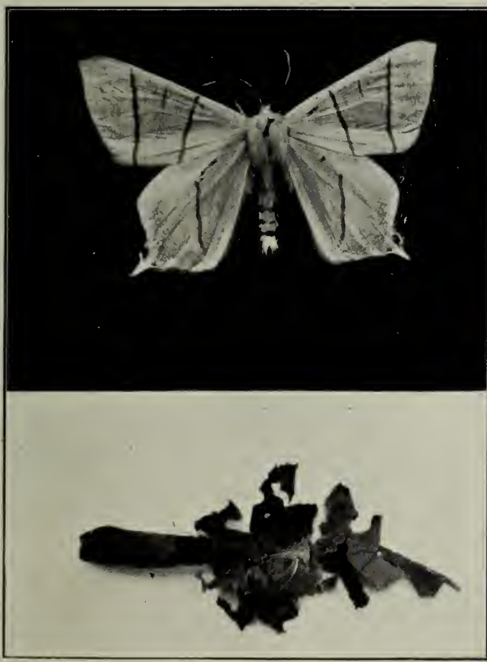
Ova x 14. (A) and Larvae x 18 (B) of the Apple Sucker (*Psylla mali* Sch.).

PLATE X.

Euthrips pyri Daniel, Female and ovum in body.

Euthrips pyri Daniel, Female, showing position often assumed when crawling and ovum crushed partly out of body.

Plate XI.



[*F. Edenden.*

The Swallow Tail Moth (*Uropteryx sambucaria* Linn.) and Pupa and Cocoon.

PLATE XII.

A.

B.

The Hop Damson Aphis (*Phorodon humuli*) on Apple. B. enlarged cornicles.

PLATE XIII.

[*F. Edenden.*

Currant Shoot damaged by Springtails (*Sminthurus luteus* Lubbock.)

Plate XIV.

B.

The Pear Midge (*Diplosis pyrivora* Riley)
A. Male; B. Female (greatly enlarged).

Plate XV.

A.

B.

C.

A. Ova of Pear Midge (*Diplosis pyrivora* Riley) greatly enlarged. The left balsam preparation, right when fresh laid.
B. Male genitalia.
C. Female, ovipositor extended.

PLATE XVI.

Plums damaged by Gall Mites (*Eriophyes phlœocoptes* Nalepa).

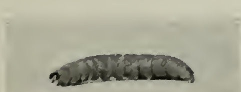
PLATE XVII.

Plum fruitlets damaged by the Plum Leaf Gall Mite.
(*Eriophyes phlæocoptes* Nalepa.)

PLATE XVIII.

A.

B.



C.

The Strawberry Button Moth (*Peronea comariana* Zeller).

A. Moth ; B. Pupa ; C. Larva ($\frac{1}{3}$ enlarged).

Plate XIX.

B.

A.

C.

[F. Edenden.

Strawberry Button Moth Damage.
A. and B. Spun up leaves ; C. damaged blossoms.

Plate XX.

C.

A.

B.

The Corn and Grass Borer (*Apamea oculea* Linn.).

A. Wheat attacked by young larva, C; B. Varieties of the Moth.

Plate XXI.

The Gout Fly (*Chlorops taeniopus* Mg). Abnormal attack. Note the small second growth with stunted ear (left), and swollen first growth.

Plate XXII.

A.

B.

C.

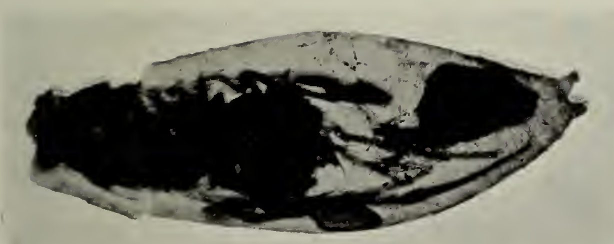
A. Seedpods of Swedes attacked by *Cecidomyia brassicae* Wtz.
B. Ova of Mangold Fly (*Pegomyia betae* Curt.). (Photo by Blakey.)
C. Wheat Bulb Fly (*Hylemyia coarctata* Fl.).

Plate XXIII.

The Gall-forming Mangold Aphis (*Aphis atriplicis* Linn.) on Atriplex.

Plate XXIV.

A.

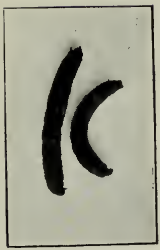


B.

Limosina curtiventris. Stnh. A., and puparium with escaping fly, B.

PLATE XXV.

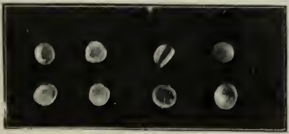
A.



B

Adult (A.) and larval (B.) *Bibionidæ*.

C.



D.

Bean and Pea Seed Beetles (*Bruchidae*).

C. Beans attacked by *Bruchus flavimanus*; D. Cuttings left from seeds C.

PLATE XXVI.

A.

B. [Blakey.

The Cabbage Aphis (*Aphis brassicae* Linn.).

A. Winged ; B. Wingless females.

PLATE XXVII.

The Yellow Springtail (*Sminthurus luteus* Lubbock).

[*F. Edenden.*

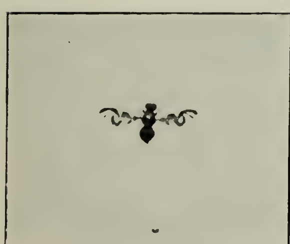
Potato Shoot damaged by Springtails (*Sminthurus luteus*).

Plate XXVIII

Knot Root produced by Eelworm (*Heterodera radicicola* Greeff).

Plate XXIX.

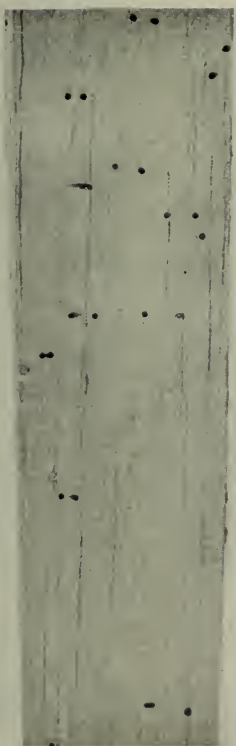
A. [*Hammond*



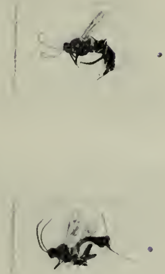
B. [*Edenden.*

The Celery Fly (*Acidia heraclei* Linn.).
A. Damaged leaf ; B. adult fly.

Plate XXX.



A.

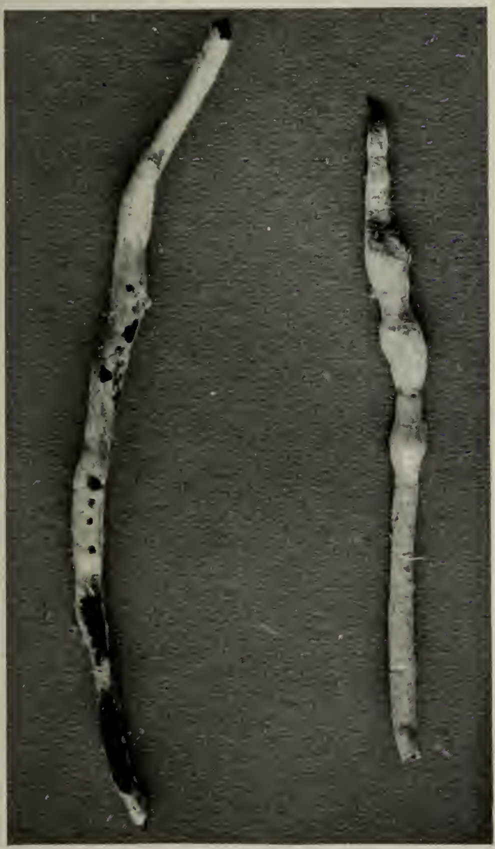


B.

C.

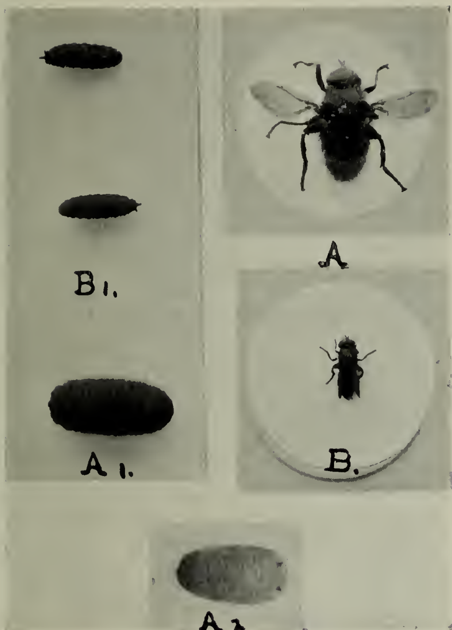
A. Wood attacked by *Xyleborus perforans* Woll.
B. Mediterranean Flour Moth Parasite (*Olesicampa flaviventris*).
C. Therevid larvæ.

PLATE XXXI.



Damage to Cattleyas by a Cecid Maggot (*Cecidomyia cattleyae* Molliard) and the Cattleya Fly (*Isosoma orchidearum* Westwood.)

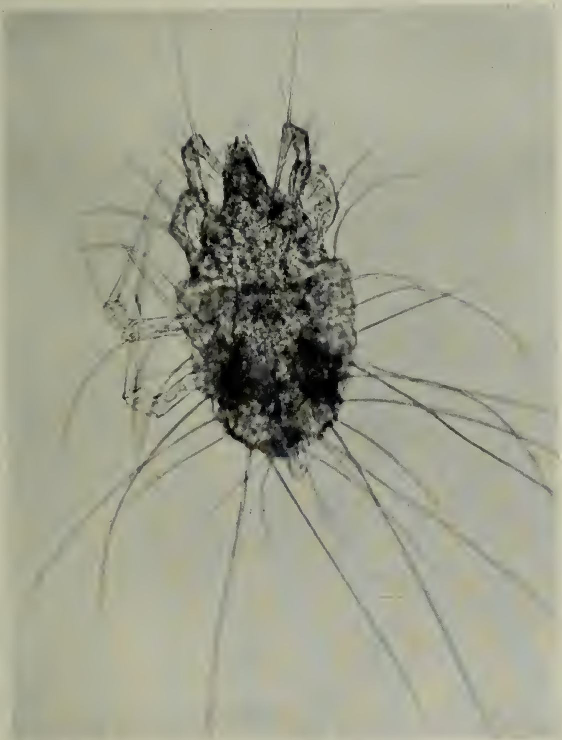
PLATE XXXII.



C.

The Narcissus Bulb Flies (*Merodon equestris*), etc.
A. and C. Adult *Merodon equestris* Fab., nat. size and enlarged;
B. and B1, Adult *Eumerus strigatus* Fln. and larvæ; A1 and A2,
Larval and pupal Merodon.

Plate XXXIII.



A.

B.

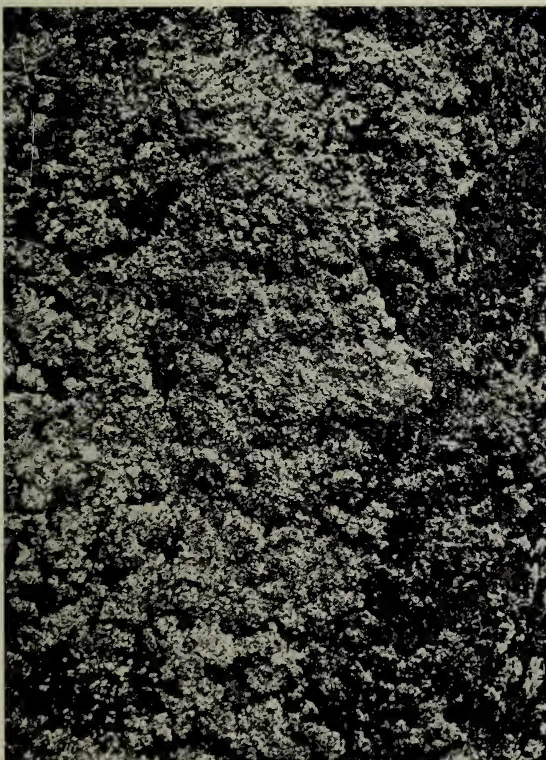
A. *Tyroglyphus longior* Gerv.; B. *Rhizoglyphus echinopus* F. & R.
(Both greatly enlarged).

Plate XXXIV.

The Elm Bark Beetle (*Scolytus destructor* Oliv.).

A. Damage. B. Adult (slightly enlarged).
X. Mother gallery. X 1. Larval galleries.

Plate XXXV.



Piece of Beech covered with *Cryptococcus fagi* Bar.

Plate XXXVI.

[F. Edenden.

Scots Fir (*Pinus sylvestris*) attacked by *Pineus pini* Linn.

PLATE XXXVII.

Hop Samples damaged by *Niptus hololeucus* Fald. (Note holes from which the beetles have escaped).

REPORT FROM THE

CHEMICAL DEPARTMENT

BY

S. J. M. Auld, D.Sc. (Lond.), Ph.D., F.I.C., F.C.S.

NINTH REPORT

FROM THE

ANALYTICAL LABORATORY.

BY

R. H. Carter, M.S.E.A.C., and S. J. M. Auld, D.Sc.

During the twelve months ending September 30th, 1911, 278 samples were received for analysis from farmers in Kent and Surrey. These samples comprised the following :—

Manures	55	samples.
Feeding Stuffs	23	,,
Soils	37	,,
Milks	124	,,
Waters	8	,,
Miscellaneous	31	,,
Total	278	,,

Compared with previous years, these figures show a considerable increase in the number of substances examined in all classes except milks. In the latter case a decided falling off has taken place, and during the period under review the number of milk samples examined has amounted to little more than 50 per cent. of the average number received during the past three years. This may, in part, be explained by the fact that we know of several instances where dairy farmers who previously sent samples of milk regularly for examination now perform the analyses themselves, and possibly this may be so in other cases which have not come to our knowledge. Considering the ease and rapidity with which

butter fat determinations can be carried out by means of the Gerber method it is to be hoped that this practice will be more widely adopted, as in this way farmers will best obtain regular and definite information as to the quality of their milk supply. It should be pointed out that creamometer tests are quite unreliable, and may be most misleading ; yet it is apparent that many farmers retain them in use—often with very equivocal results.

The desirability of forwarding as much information as possible with samples sent for analysis has frequently been emphasized in previous issues of this report, and it is much to be regretted that so little notice is taken of the request. During the past session many instances have occurred where fuller and more definite reports could have been made if some particulars regarding the samples in question had been available. Moreover, considering the number and varied nature of the samples examined in this laboratory, a valuable supply of co-relative information could thus be collected, which would often be of great service to farmers, and would frequently considerably enhance the value of any particular analysis.

Analyses carried out for other Departments.

In addition to the analyses mentioned above, it has again been necessary to undertake numerous estimations of nicotine in tobacco and of soft resin in hops, in connection with experiments carried on by other departments. Analyses have been made of 54 samples of hops, and 210 samples of tobacco. The results will be found embodied in the reports upon the tobacco and hop experiments. Determinations of total solids, specific gravity, and butterfat were also made in the case of 600 samples of milk taken from the College herd during the months of July, August and September.

MANURES.

The samples examined this year have consisted, almost without exception, of organic manures and waste organic substances. Such materials being, as a rule, subject to great variation in composition, as well as to actual sophistication, should always be bought on the results of analysis, and it is

gratifying to note that in this connection the work of the analytical department is considerably increasing. Very few of the standard artificial manures were received ; they are now so well known that adulteration is rare, and the guarantees required by the Fertiliser and Feeding Stuffs Act generally provide sufficient protection for the purchaser. Occasionally, however, efforts are made to get round this requirement, and the purchaser should see that the analysis is clearly printed on the invoice.

Fraudulent and low class manures, particularly amongst the slow acting "organic" manures of the shoddy type, have been offered in many cases to farmers in Kent and Surrey. Attention will be called to several actual samples of this kind later on. The sharp practice in most cases consists in taking advantage of the hop-grower's well-known partiality for bulky organic manures and attempting to sell material consisting chiefly of cellular fibre of the cotton type, which contains practically no nitrogen, in place of the highly valuable nitrogenous materials derived from wool. In most cases the simple test of burning a portion of the manure, or suspicious looking fibres contained in it, will quickly detect the substitution, apart from the actual analysis, which unfortunately in many cases still conveys very little meaning to the farmer. The valuable nitrogen manures do not burn readily but char and sinter and give off a smell of burning hair. Cellulose materials on the other hand burn much more readily, producing a smell like burning brown paper.

UNIT VALUATION OF MANURES.

Few farmers require to be reminded that artificial manures are valued on the system of giving to each of the manurial elements present—nitrogen, potash and phosphates—a definite value per unit, the unit being 1 per cent. or one-hundredth part of a ton. Owing particularly, however, to the difficulties which beset the way of the purchaser of organic nitrogenous manures, in which the unit values vary considerably and for which figures are rarely available, it is desirable that unit values for such materials be calculated at the College, and for this reason a short *résumé* of the method will first be given.

Sulphate of ammonia contains 20 per cent. of nitrogen. The present price is £14 16s. per ton, so that one unit of nitrogen in the manure has the value 14s. 10d. Similarly in nitrate of soda the unit value works out to 13s. 11d. Frequently in manure invoices, etc., the nitrogen is not only expressed as pure nitrogen (N) but as Ammonia (NH_3), seventeen units of which are equivalent to fourteen of nitrogen. Expressed as ammonia, therefore, the unit in sulphate of ammonia is 12s. 3d. and in nitrate of soda 11s. 6d.

The analysis of potash manures is generally given in terms of pure potash (K_2O). If Kainit, containing 12 per cent. of K_2O costs £2 8s. per ton, then the unit value of K_2O is 4s., which is the present value. Potash in sulphate and muriate of potash is worth 4s. 9d. and 4s. 4d. per unit respectively. The analysis of a manure may sometimes be illegally stated as sulphate of potash (K_2SO_4) or muriate of potash (KCl) instead of as pure K_2O. This may be very misleading to the farmer and lead to a wrong idea of cheapness, since a unit of K_2SO_4 contains only .54 of a unit of K_2O, and a unit of KCl equals only .63 of a unit of K_2O. In whatever form the vendors' analysis is expressed the potash content should be transformed to K_2O before calculating the unit value.

In the case of phosphatic manures the difference is still greater, as the phosphoric acid may be expressed as P_2O_5 or more generally as tricalcium phosphate $Ca_3(PO_4)_2$. One part of the former is equivalent to 2.18 of the latter. The unit value of phosphate, calculated from the analysis and from the price per ton as above, varies according to the source and the "availability" of the manure. It is highest in superphosphate, and lowest in ground mineral phosphates. The unit values at the time of writing are 2s. for phosphate soluble in water (in superphosphate), 1s. 7d. for the citric-acid-soluble phosphate of basic slag and 1s. 3d. for insoluble phosphates from bones, guano, etc.

In arriving at the value for a mixed manure the current unit values of the different manurial elements are multiplied by their respective percentages, as given by the analysis. The sum of these added together gives the intrinsic value of the manure.

It will be seen from the above considerations that the

different unit values vary considerably according to the source of the material, and fluctuate with the market price. For the ordinary artificial manures, as well as for guanos, etc., the current unit values are frequently given in tabular form by certain of the agricultural newspapers. No recent figures are available, however, for organic manures like shoddies, wool wastes, cloth and fur wastes, hair wastes, etc., which are extensively used in the South-Eastern Counties. There is no doubt that the manurial value of the combined nitrogen in these substances varies enormously, and we appeal particularly to farmers and growers sending us samples of such manures to inform us of *the price* asked for the particular parcel. In the case of out of the way manures like Destructor refuse, Town wastes, and various offals, it is particularly difficult to obtain unit values. If the prices at which these manures are put on the market were communicated to us, we would, in conjunction with the analysis and the manurial value of such substances, be in a position to tabulate a series of unit values for such fertilizers which would be of considerable value to the growers and others consulting us on the subject.

AVAILABILITY OF ORGANIC MANURES.

On the question of the measurement of the availability of the nitrogen in the different organic manures, little work has been done during the year. It is, of course, notorious that the nitrogenous material in fish guano is much more readily "available" to the plant than that of shoddies, and the latter than the very slowly decomposed hair wastes. There is still, however, no simple analytical method of measuring the different rates of availability, although the matter is one of some importance.

A recent communication by Lipman, Brown and Owen (*Journ. Chem. Soc. Abs.*, 1911, ii. 924) has shown by trials with a number of different proteins that the availability of nitrogenous materials may possibly be measured by their rate of ammonification, *i.e.*, the formation of ammonia from the complex nitrogenous bodies as produced on incubation with a loamy soil mixed with sand. There are many difficulties about the standardization of such a method for analy-

tical purposes, but if they can be overcome valuable comparative figures for the availability of the nitrogenous material in organic manures would doubtless be obtained.

SHODDY, WOOL DUST, FLOCK DUST, CLOTH WASTE.

Very large quantities of these manures are used by hop growers and fruit growers in Kent, and a considerable number of samples were sent for examination. The analyses quoted below give a good idea of the quality of the samples received.

Ref. No.	Description.	Nitrogen.	Equiv. to Ammonia.	Moisture.
947	Flock Dust	5.29	6.44	2.20
967	Shoddy	3.46	4.20	7.83
983	Shoddy Waste	5.13	6.23	8.96
986	Shoddy	4.07	4.94	20.57
27*a*	Wool Dust	8.71	10.56	11.11
27*b*	Wool Dust	7.91	9.59	10.56
93	Shoddy	1.18	1.44	26.56
131	Shoddy	3.83	4.65	9.59
132	Shoddy	4.88	5.93	7.59
154*a*	Cloth Waste	6.50	7.89	9.42
154*b*	Wool Waste	3.55	4.31	7.92
226	Grey Shoddy	3.65	4.43	9.07
227	Grey Shoddy	3.95	4.79	20.24
264	"Flights"	12.29	14.92	13.11

With the exception of No. 264, the samples were all of low or medium grade. In the majority of cases the mechanical condition was satisfactory, but as will be seen from the above figures, the moisture content varied considerably.

Attention must be drawn here to sample No. 93. This was a particularly poor material, and although fraudulently sold as shoddy, appeared to contain no woollen refuse whatever. It closely resembled another sample received under the name of "Manilla wastings," to which reference is made on page 260, and consisted of decayed sacking mixed with coal dust. It must be obvious that such substances possess practically no manurial value.

Shoddy waste No. 983 and Wool waste No. 154 were genuine samples, but both contained considerable quantities of Lucerne and other seeds, in addition to much sandy matter. Several other samples very similar to these were examined. In the majority of cases, however, the wool wastes analysed were in excellent mechanical condition and very free from sand.

Two samples of Grey shoddy Nos. 226 and 227, offered at 32s. 8d. per ton, contained respectively 14.6 per cent. and 25.34 per cent. of sand; and No. 227, guaranteed to contain 5.5 per cent. ammonia, was in a very moist condition. The apparent deficiency in nitrogen was, of course, due to the high moisture content, which was explained by the fact that the sample sent for analysis was drawn from a truck load of the shoddy which had been exposed to wet weather. Grey shoddy varies greatly in composition, probably more than any other class of woollen manure, owing to the high percentage of sand and other impurities which it invariably contains. Nevertheless, it is generally used by fruit growers in preference to other kinds, because of the belief that its effects are more lasting. It is possible that decomposition in the soil may proceed more slowly in the case of grey shoddy, for all the samples we examined were more lumpy and generally in a much coarser and less decomposed condition than the black shoddies.

Sample No. 264—sold as "Flights"—was the only high grade sample received. It was highly coloured, and in remarkably clean condition. Apparently it consisted of carpet clippings; very little cotton refuse was present. Unfortunately no information as to price and source of supply was vouchsafed.

With regard to the market value of nitrogen in the lower grades examined, it appears from the few instances in

which the price per ton could be ascertained that 7s. per unit is a fairly constant figure.

HAIR MANURES.

		Nitrogen.	Equiv. to Ammonia.
960	Rabbit Waste	7.85	9.53
966	Rabbit Waste	7.75	9.41
967	Fur Waste	11.40	13.84
153	Fur Waste	12.57	15.27
284	Hair Waste	10.87	13.20

Hair waste, Fur waste, etc., decompose only slowly in the soil, and they do not appear to be used to anything like the same extent as are shoddies and other woollen material. The samples analysed call for little comment. Nos. 960 and 966 were sent as rabbit wastes, but neither could be considered a true rabbit waste, which consists of ears, feet and tails of rabbits, in addition to fur. These samples contained fur only, mixed with much sand and extraneous matter, and the percentage of nitrogen consequently was much lower than it should have been. Good samples of rabbit waste contain 10 to 13 per cent. of nitrogen.

The Fur waste, No. 967, was a curious sample. It consisted of comparatively large portions of articles of fur clothing, together with some large and brilliantly dyed feathers. Although very clean, the sample was of doubtful value on account of the fact that it was composed of large fragments of material which would certainly take a long time to decay. Sample No. 153 proved to be a remarkably clean Rabbit Fur waste. The Hair waste, No 284, was a greasy sample, and contained 14.04 per cent. of oily matter.

The question of the effect of oily material in a manure is still undecided. It seems probable that the effect may be deleterious owing to the oil surrounding the particles of manure, and preventing their disintegration in the soil. Besides

this numbers of chemical substances allied to the oils have been shown to act toxically towards plants and the oily materials themselves may possibly have this effect. On the other hand there are known to be present in the soil numerous bacteria possessing a fat-splitting or lipoclastic action, and these would probably gradually remove the oil. It is hoped to institute experiments at the College to throw light on the subject. (See also the article on " Nitrate of Lime treated with Mineral Oil," p. 352.)

GUANOS, FISH MANURES, ETC.

(See Table I., p. 256.)

Comparatively few Fish Guanos reached us this year. Good quality fish guano forms an excellent manure, and is very popular with hop-growers; consequently the price of the best samples is high, and tends to rise. As, however, almost all kinds of fish refuse are now sold as fish guano, a good deal of inferior material is met with, and the uniformity in composition of this manure mentioned in previous reports has not been so noticeable in the samples dealt with during the past year. The three analyses quoted illustrate the wide variation in quality. No. 968 was a good sample, and at the time of examination was worth at least £6 10s. per ton. Nos. 110 and 274 were distinctly inferior; the latter was a poor quality herring waste, and contained a high percentage of mineral matter.

No. 70, sold as a Fish and Blood Guano, was quoted at £6 per ton carriage paid. It was a bulky material, and although about 10 per cent. of extraneous matter—pieces of wood, stone, glass, etc.—was present, the mechanical condition, on the whole, was satisfactory. The name Guano, however, should not be applied to substances which, like the sample in question, are nothing more than offals.

Sample No. 16, sent as Quail Guano, consisted of sweepings from quail houses. The droppings were mixed with a very large proportion of millet and other seeds, which would be very likely to germinate if the manure were applied to the soil without previously being made into a compost.

No. 88, sold as Native Guano at £7 10s. per ton, was sent for analysis by the unfortunate purchaser. In appearance

TABLE I.

Ref. No.	Description.	Nitrogen.	Equiv. to Ammonia.	Phosphoric acid.	Equiv. to $Ca_3 P_2 O_8$	Potash.	H_2O + organic matter.	Sand.
968	Fish Guano	7.76	9.42	6.31	13.77	—	72.46	—
110	Fish Guano	4.38	5.32	3.20	6.99	—	37.22	—
274	Fish Guano	1.61	1.95	6.21	13.55	—	40.28	23.92
70	Fish and Blood Guano	4.83	5.87	4.14	9.04	—	60.86	—
16	Quail Guano	3.66	4.43	1.81	3.95	1.01	85.15	8.07
88	Native Guano ..	1.64	2.00	3.90	8.52	.45	49.86	27.40
55	Peruvian Guano ..	4.62	5.60	15.08	32.92	2.28	—	25.04

it resembled ordinary soil, and it certainly contained a considerable admixture of earthy matter, as is frequently the case with this class of substance. Native guano contains, as a rule, very little fertilizing material, and even the small quantity present is not in a readily available form. The price asked is usually out of all proportion to the actual manurial value, and this sample proved to be no exception to the rule. At the outside it was not worth more than 40s. per ton.

One sample of Peruvian Guano was examined, and requires no special comment. It was a good sample of phosphatic guano; nearly half the nitrogen present was in the form of Ammonium salts.

BONE MANURES.

Ref. No.	Description.	Nitrogen	Equiv to Ammon'.	Phosphoric acid.	Equiv. to $Ca_3 P_2O_8$	Sand.
68	Bone and Blood Mixture	1.48	1.80	5.40	11.79	23.49
3	Steamed Bone Flour	.90	1.90	29.85	65.14	—
974	Bone Meal	3.80	4.61	20.54	44.83	—
193	Bone Meal	4.38	5.32	21.26	44.24	3.32
206	Bone Meal	4.28	5.20	21.86	47.72	.91
266A	Bone Meal	5.22	6.33	21.04	45.94	.31
266B	Bone Meal	5.53	6.72	19.33	42.18	.19

The bone manures examined this year included some of the best samples we have seen, and, with the exception of Nos. 68 and 974, were eminently satisfactory.

The Bone and Blood Mixture, No. 68, was an extremely acid, pasty sample. The phosphate was soluble in water, and a considerable quantity of free sulphuric acid was present. The material had undoubtedly been badly prepared, and its very acid nature rendered it unsuitable for use on any soil

not well supplied with lime. No information as to price was available.

A sample of Steamed Bone Flour, No. 3, was well above its guarantee of 1 per cent. Ammonia and 60 per cent. phosphate. Bone Meal No. 974 was satisfactory as far as the chemical analysis was concerned, but it was very coarse, and contained many pieces of bone which had not been properly crushed. The other bone meals quoted were excellent samples, in all cases above the guarantees.

No. 206 was offered at £6 per ton. The high nitrogen content of Nos. 266A and B would indicate that they were made from bones which had not been subjected to any extraction process other than ordinary household use. As a rule, bones are steamed for some hours at 15 to 20-lbs. pressure to remove fat, which is sold as tallow. They are then crushed, ground and sold as bone meal. In addition to removing the fat, the steaming may cause a small loss of nitrogen compounds, and bone meals manufactured direct from raw bones generally contain a somewhat higher percentage of nitrogen. On the other hand bones which have been subjected to a preliminary steaming can be more finely ground, and both the samples above mentioned were noticeably coarser than the others quoted in the table, with the exception of No. 974.

In the manufacture of glue, the bones, after the first steaming, are broken up and again steamed, this time at a pressure of nearly 50-lbs. to the square inch. The solution obtained is run off, concentrated, and allowed to set, forming cakes of glue. The residue after crushing and grinding is known as Steamed Bone Flour.

MISCELLANEOUS MANURES.

(See Table II., p. 259.)

These include some interesting samples, which deserve special mention. Nos. 46 and 69 were mixed manures. The first, known as Limolite, was in a very fine state of division, and very well mixed ; the nitrogen was in the form of ammonium salts and the phosphates were entirely soluble in 2 per cent. citric acid. In addition to the constituents given in the table 17.20 per cent. of calcium carbonate was present.

TABLE II.

Ref. No.	Description.	Nitrogen.	Equiv. to Ammonia.	P_2O_5	Equiv. to $Ca_3P_2O_8$	Potash.	Sand.
46	Limolite	3.33	4.05	6.88	15.01	6.41	—
69	Mixed	2.89	3.51	5.05	11.02	11.21	—
82	Rape Dust	5.98	7.26	1.30	2.84	—	—
83	Manilla Wastings ..	1.04	1.28	.24	.54	1.20	10.20
135	Rag Refuse	2.12	2.57	—	—	—	—
59	Cotton Seed Waste ..	.91	1.10	—	—	—	—
60	Cotton Seed Waste ..	.93	1.13	—	—	—	—
61	Cotton Seed Waste ..	.11	.13	—	—	—	—
252	Esparto Grass Dust	1.72	2.08	1.79	3.91	4.12	22.17

Ammonia was readily given off on warming and moistening, and unless the bags were carefully stored in a cool, dry place, a considerable loss of ammonia would take place. No. 69 was a very similar material, containing, however, more potash and less phosphate.

Sample No. 83—euphemistically termed "Manilla wastings"—affords an illustration as to the manner in which farmers who put their faith solely in organic manures may be defrauded by unscrupulous merchants. It is still a matter of common belief among the less enlightened members of the farming community that organic substances, in any shape or form, possess a manurial value much above that of any "artificial" or "chemical" manure, and it is, therefore, hardly a matter for surprise that "sharp" dealers sometimes succeed in selling worthless refuse material at high prices. The "Manilla wastings" mentioned above consisted solely of semi-decayed sacking, in a very moist condition, mixed with coal dust and sandy matter. It will be seen from the analysis that the manurial value was extremely small, particularly when it is remembered that the nitrogen was derived mainly from coal dust, and the moisture present amounted to 49.36 per cent. Yet this material was claimed to be an excellent manure for hops and roots, resulting in heavy yields, and producing in the case of hops a beautiful bright and clear colour. It was offered at £4 10s. per ton. The vendor laid especial stress upon the fact that it was a "pure" manure, containing no artificial whatever; he admitted that it was "a little damp," and offered to make an allowance on that account, but pointed out that it would "give the roots moisture and manure at the same time."

A sample of Rag refuse, No. 135, was in very coarse condition, containing large pieces of leather and cotton rags. It was of little value, and required to be made up into a compost and allowed to decay before being applied to the soil. The price asked was 20s. per ton loose in trucks, 25s. per ton in bags with an extra charge of 5s. per ton carriage. The material was certainly not worth 25s. per ton; it is doubtful whether it was worth more than 12s.

Three samples of Cotton seed waste were sent in by a hop grower who had an offer of some quantity at 15s. per ton.

The material was essentially cotton wool mixed with some cotton seed husk, and was of no value as manure. Sample No. 61 contained much less husk than the others, and consequently yielded a lower percentage of nitrogen.

The Esparto Grass Dust (No. 252) was a by-product from a paper factory, and was stated to contain about 5 per cent. ammonia, 5 per cent. phosphates and 7 per cent. potash but was offered without any guarantee. Such material would doubtless be of very variable composition, and the sample sent for analysis contained considerably less than these percentages. It was in a very fine, powdery condition; a considerable amount of waxy and resinous substances was present. The price asked was 35s. per ton, and the cost of carting brought the price up to 36s. 6d., which is approximately what the material was worth.

FEEDING STUFFS.

In the majority of cases the cakes and meals sent in for examination have been standard materials of good quality, and need no special mention here. Analyses of some of the more interesting samples are given in the following table. For a discussion of the general method of analysis and value of the various food constituents reference should be made to last year's report.

(See Table III., p. 262.)

Two Compound Cakes, Nos. 7 and 40, were of similar composition, and in good condition. Both were highly spiced.

The manufacture of compound cakes provides a ready means whereby much inferior material can be made up into a very presentable form, and sold at considerable profit. A cake may show, on analysis, quite high percentages of oil and albuminoids, and yet be of very little feeding value, on account of the presence of much indigestible fibre. Again, sweepings of cake mills are sometimes mixed with the usual spices and converted into compound cakes; in such cases the quantity of sand introduced into the cake may be so great as to prove actually injurious to stock. It is apparent that the provisions of the Fertilizer and Feeding Stuffs Act—which demand a guarantee of the amount of oil and albuminoids

TABLE. III.

Ref. No.	Description.	Oil.	Protein.	Nitrogen.	Fibre.	Nitrogen free extract.	Mineral matter.	Sand.	Moisture.
7	Compound Cake ..	8.26	19.00	3.04	9.56	40.00	9.37	1.16	13.81
40	Compound ,, ..	7.33	19.16	3.06	10.17	45.81	7.80	1.77	9.73
30	Linseed ,, ..	5.58	29.63	4.74	8.97	37.09	6.83	1.22	11.90
7a	Undec. Cotton Cake ..	5.42	24.19	3.87	20.88	31.62	5.47	.22	12.42
56	Rape Knibs	9.92	33.50	6.36	8.54	28.08	10.27	2.74	9.69
143	Niger Seed Cake ..	5.34	30.56	5.93	19.08	27.68	8.70	1.12	9.14
57	Meal	5.66	17.25	2.76	9.38	41.75	14.68	7.37	11.28
8a	Cod Liver Oil Condiment	14.63	15.94	2.55	6.55	44.90	6.04	.21	11.94
8b	Molasses Food	2.52	9.40	1.51	9.20	50.89	7.00	.22	20.93

only—are not sufficient fully to protect the purchaser, and it is desirable that the percentage of crude fibre should also be included in the guarantees demanded. It is satisfactory to note that this matter has recently received recognition at several large farmers' clubs.

On the other hand the compound cake manufacturer is able to take advantage of the many new and quite wholesome feeding stuffs now imported from different parts of the world, which the farmer frequently has little opportunity of obtaining for direct consumption on the farm, even if he were willing to do so.

The two samples quoted above had evidently been made from clean materials, and the sand present was not excessive. The proportion of crude fibre also was quite low.

No. 30, a sample of Linseed Cake, was very hard, and low in oil content. It was probably a "new process" American cake. Some starch was present, but the grains had become too much altered by the heating used in the process of manufacture to admit of identification. The formation of prussic acid from linseed cake is treated fully elsewhere.

POSSIBLE POISONOUS ACTION OF COTTON SEED CAKE AND MEAL.

Undecorticated Cotton Cake (No. 7a), was suspected of having caused the death of stock (the kind was not specified). A careful examination failed to reveal the presence of castor bean, or of an injurious material, and the analysis showed the sample to be genuine and very free from sand. It was, in fact, an especially clean sample.

It has already been pointed out in this *Journal* that cotton seed cake and meal may not be a safe food in all cases. Young and pregnant animals certainly should not be fed with this material, and it has proved particularly dangerous to pigs. With one-third of their concentrates in the form of cotton seed meal these animals may thrive at first, but will eventually be seriously upset and possibly die. Indeed, Henry ("Feeds and Feeding," p. 153) states that no uniformly successful method of feeding cotton seed meal to swine has yet been found.

Many attempts have been made to isolate the poisonous

constituent of cotton seed, but without complete success. Recent work by Mohler and Crawford of the U.S. Department of Agriculture (Expt. Stat. Rec., 1910, 22, 501) appears to show that the toxic action is due to salts of pyrophosphoric acid, the quantity of which is greatly increased by heating. This indicates that the poison is probably largely developed during the hot crushing of the oil seeds, and may possibly be avoided by the use of presses which remove the oil at low temperatures.

No. 56 was a good sample of Rape Cake, but this material always suffers from the peculiarity of giving a mustard-like smell on maceration with water, and is frequently refused by stock unless they have been gradually accustomed to its use. For this reason, rape cake, when employed as a feeding stuff, should be fed dry, but most of the material is now extracted with naphtha or some other solvent to remove the valuable oil, and the residue used as a manure in the form of the well-known rape dust.

Sample No. 143 was of a very dark, almost black appearance, fairly hard, and apparently homogeneous. It was identified as Niger Seed Cake, consignments of which occasionally come on the market. Compared with a sample analysed by Smetham (Roy. Lanc. Agric. Soc. Report, 1909) it was much lower in oil (5.34 per cent. against 14.03 per cent). and contained 3.5 per cent. less crude protein. If the sample examined by us were pure (and it did not obviously contain other seeds) Niger Seed Cake is apparently liable to considerable variation in composition. It is interesting to note that this sample gave 0.009 per cent. of prussic acid on soaking with water and allowing to stand for twenty-four hours (See p. 296.)

Sample No. 57, stated to be a "Feeding Meal," evidently consisted of sweepings and was one of the dirtiest samples we have examined. It presented a most unwholesome appearance, and the high proportion of mineral matter and sand present was quite sufficient to condemn its use as a foodstuff for anything except pigs.

No. 8a. Cod Liver Oil Condiment. This consisted of oat meal and crushed linseed, together with a considerable quan-

tity of Fenugreek, and possibly other spices; Cod Liver Oil had been added, and the oil content was high. The mixture was very clean and had evidently been carefully prepared. It would undoubtedly prove a valuable food for calves, but the price asked—£30 per ton—was enormous.

The Molasses food (No. 8b.), was similar in appearance to a sugar food sold as "Barmak" or "Makbar." The base used for absorbing the molasses was found to consist of fragments of hops—probably spent hops from a brewery. Extracted hops do not form a particularly valuable feeding stuff, they contain over 17 per cent. of indigestible crude fibre, and the starch equivalent is about the same as that of cereal husks. Compared, however, with many of the absorbents used for molasses feeds—treated sawdust, earth nut and coffee husks, etc.—the material appears in a more favourable light.

WATERS.

The interpretation of the results of water analysis, and the characteristics of the water supply from the various geological formations occurring in Kent and Surrey have been fully discussed in previous reports. It is only necessary here to add a few remarks on the samples received during the year.

(See Table IV., p. 266.)

Sample No. 950 was pumped from a freshly sunk well on a farm belonging to an estate in the neighbourhood of Sandhurst, Kent. Sandhurst and its immediate surroundings are situated on a cap of Tunbridge Wells sand overlying the Wadhurst clay. We were not informed as to whether the farm was actually on the clay formation, but the water undoubtedly possessed the typical characteristics of clay waters, namely, a high chlorine content, and excessive amounts of dissolved solids.

The large proportion of solid matter present was, in itself, sufficient to render this water very undesirable for drinking purposes; but the sample further showed very distinct indications of organic contamination, and, moreover, zinc salts were present in quantity sufficient to produce a decided opalescence when H_2S was passed through the liquid. Con-

TABLE IV.

WATERS—Parts per 100,000.

Ref. No.	Locality.	Total solids.	Ammonia free and Saline.	Albuminoid Ammonia.	Nitrogen as Nitrite.	Nitrogen as Nitrate.	Oxygen absorbed in 4 hours.	Chlorine.	Hardness.
950	Sandhurst, Kent	135.86	.098	.164	quantity	1.02	.144	11.70	59.21
951	Sandhurst, Kent	6.06	.084	.022	quantity	.047	.072	1.30	3.90
18	Witley, Surrey	33.36	.006	.010	nil	.870	.020	2.10	19.84
19	Witley, Surrey	34.00	.018	.010	trace	.800	.027	2.30	19.95
17	Leeds, Kent	92.60	.012	.013	nil	1.80	.005	4.10	53.75
86	Ash, Canterbury	165.00	.006	.054	heavy trace	2.78	.260	33.32	66.50
126	Sandhurst, Kent	14.86	.0004	.005	nil	.544	.005	3.60	6.08
147	Ashford, Kent	12.84	.003	.008	faint trace	.125	.283	2.80	3.58

sidering the fact that the well was a new one, it would have been unwise to attach too much importance to the indication of organic contamination; and the presence of zinc compounds, derived undoubtedly from the galvanised iron piping utilized in the construction of the pumping apparatus, would probably prove to be of temporary duration. It is evident that the water was quite unfit for human consumption in the condition in which it was received, and although, in time, considerable improvement might have taken place as far as the presence of organic matter and zinc salts was concerned, the high solid content was not likely to diminish, and would always render the supply undesirable for domestic use.

No. 951 was a sample of filtered Rain Water from the same district. The analysis clearly showed that organic contamination had occurred to a very serious extent, and until the source of contamination could be traced it was quite impossible to state whether or not the supply could be used for drinking purposes. At first it seemed difficult to account for the presence of so much organic material, as the sender affirmed that all water courses, filters, etc., had been thoroughly cleaned out a short time before the sample was drawn. A more careful examination, however, revealed the fact that a small collecting tank had been overlooked in the cleansing process, and remained partially blocked with decaying leaves. The discovery, of course, removed all doubt as to the suitability of the water for human consumption.

Two samples, Nos. 18 and 19, represented the same supply (Godalming Water Works), but No. 18 was drawn from the main, while No. 19 was taken from the storage cistern of a private house. The water in use in this house had fallen under suspicion, and information was desired as to the suitability of the main supply for drinking purposes, and the possibility of contamination occurring in the passage of the water through the cistern. Reference to the figures given in the table will show that the water taken from the main was quite satisfactory; it was of moderate hardness and gave no indications of contamination. In the sample taken from the cistern some evidence of organic contamination certainly appeared; whether this was due to the presence of vegetable

matter, or to animal remains, in the shape, possibly, of some unfortunate rodent, could not be ascertained, as no further communication concerning these samples was received.

Sample No. 17 was water from a well 60ft. deep supplying the cottages on a farm near Leeds, Maidstone. The sender stated that the well was not in the neighbourhood of any cesspools or mixens. The formation from which this water was derived was mainly the Kentish Ragstone. The farm in question, however, was situated on a narrow belt of Atherfield clay, surrounding a small area of Weald clay which occurs in the neighbourhood of Leeds, and possibly the great hardness and high solid content of this water were due, in part, to infiltration from the clay beds. The figures for both free and albuminoid ammonia were rather higher than they should be ; the contamination, however, was not serious, and any danger could be avoided by boiling. The chief objection to the sample was its solid content.

No. 86 represents a sample of water taken from a shallow well, on a farm situated on the Thanet beds in the neighbourhood of Ash, Kent. The water was obviously badly contaminated, and quite unfit to drink. The high figure for albuminoid ammonia, the presence of nitrites, and the very high chlorine content all indicated recent contamination. Moreover, the water was excessively hard and contained large quantities of dissolved solids. The solids from 500 cc. of this water contained sufficient phosphates to give a precipitate with ammonium molybdate solution—a fact which further confirmed the opinion that serious organic contamination had occurred. It was ultimately ascertained that the well was only 10 feet from an open cattle yard, and so situated that the chief springs supplying it flowed directly beneath the yard. The fact that the well was shallow, and placed in such a position on a very pervious formation, fully accounted for the dangerous condition of the water.

Sample No. 126 taken near Sandhurst, Kent—a locality previously mentioned—was stated to have been drawn from a field drain pipe which continued to discharge throughout the very dry summer of 1911. There was reason to believe that the source was a spring situated near the centre of the field, and in the event of the water proving suitable for drink-

ing purposes it was intended to conduct the supply to neighbouring farm buildings. The figures quoted in the table show that this water was exceptionally pure ; it was, in fact, the purest sample we examined—the hardness and total solids being remarkably low. Whether or not contamination might occur during periods of continued wet weather was, of course, a point that could only be decided by actual trial.

MILKS.

During the past year the samples received from farmers in the counties of Kent and Surrey have numbered 124, of which eleven were taken under the Foods and Drugs Act. Complete analyses were made in the case of twenty-one samples, and determinations of butter fat only in the remaining 103. The fee for a complete analysis, which includes the estimation of total solids, butter fat, and specific gravity, has been reduced to 2s. per sample.

Of the 124 samples examined, 23 were below the legal standard of 3 per cent. butter fat. This gives a percentage of 18.54 per cent—a figure considerably below those of the four previous years, *viz.*, 26.57 per cent., 25.60 per cent., 26.00 per cent., 26.20 per cent. ; average for the four years 26.10 per cent.

The abnormal summer of 1911 in many cases upset the usual standards of milk obtained by farmers, sometimes increasing the quality of the milk at the expense of quantity and in other cases causing a decrease, both in fat and in solids not fat, due to a bad effect on the animals. Indeed, although no actual figures are available, the impression we have received is that there were more instances of milk falling below the standards in fat *and* solids not fat during the year, resulting in the institution of a larger number of prosecutions under the Sale of Foods and Drugs Act, in many cases where there had previously been no trouble with the quality of milk supplied by the same cows. This, however, is merely an intensification of what sometimes does occur under normal conditions, and numerous cases are known where prosecutions have actually succeeded although there has been really no question of the genuineness of the milk concerned.

The reasons for genuine milk falling below the required minimal standards have been discussed in this *Journal* in previous years (cf. Report 1906) and attention has also been drawn (1909) to the interpretation of the official analysts' figures. We would like again to point out, however, that the statements of so much "added water" being present in the sample, or so much "fat removed," which appear on the official analysts' reports in the case of prosecutions, are *mere assumptions deduced from the Government limits.* There is at present no method which can definitely prove the presence or absence of added water in milk. As is well known, the Board of Agriculture has fixed the minimum standards at 3 per cent. of butter fat, and 8.5 per cent. of solids not fat, and it is on the basis of these figures that the calculation of the extent of assumed adulteration is made. Thus

"Added water"	=	$100 - \frac{s \times 100}{8.5}$
and "Fat removed"	=	$100 \times \frac{3-f}{3}$
where s	=	solids not fat
and f	=	butterfat actually found in the sample.

We do not intend to discuss the values and effects on the farmer of the standards laid down by the Government, concerning which a great deal has been spoken and written during the past year, but wish to reiterate what has already been said, *viz.*, that genuine milk may fall below these standards and that the question of "added water" or "fat removed" is one which cannot be definitely settled by analysis. Indeed the question of the genuineness or otherwise of milk is one which at present must be settled by the magistrate, and it is very desirable that some method of detecting adulteration otherwise than by mere analysis should be found, and we propose carrying out some further investigations on the point.

The general absence of information concerning samples received for analysis has already been noted in the introduction to this report. With regard to milks, in very few instances have any particulars been received as to whether the samples were morning or evening milks, mixed milks, or samples from individual cows. We desire to repeat here the remarks made in a previous issue—that it would often

be to the advantage of the sender if such information were furnished, since a determination of butter fat is not of much value unless it is considered in conjunction with such points. Where samples are sent without any note whatever, the reports must necessarily be limited to bare statements of the percentages of butter fat present; and no suggestions can be made as to possible means of improvement in cases where the butter fat falls below the legal standard.

Another point previously mentioned may be discussed more fully here. Several instances have occurred where farmers who habitually make use of creamometer tubes for testing their milks have written to us expressing surprise at the discrepancies existing between their own tube readings and the percentages of butter fat determined on the same samples at the College. It should be clearly understood that the proportion of cream indicated by the tubes is absolutely no criterion of the percentage of butter fat present; it is possible for the tubes to indicate an increase of cream, while the percentage of butter fat has actually decreased. The following examples will illustrate this fact.—

			Cream Tube.	Butterfat per cent.
Sample tested	Sept. 29th	..	10.0 points.	3.45
,, ,,	Nov. 11th	..	14.5 ,,	3.30
,, ,,	Nov. 14th	..	6.0 ,,	3.20
,, ,,	Nov. 26th	..	10.50 ,,	3.15
,, ,,	Jan. 25th	..	5.20 ,,	3.70
,, ,,	Feb. 28th	..	13.40 ,,	3.70

POISONING CASES.

Four examinations were made this year :—

No. 112.—The stomach and intestines of a horse were examined for the presence of phosphorus and arsenic. No trace of either was present.

No. 211.—In the case of several pigs, which had died suddenly, suspicion fell upon the sharps and barley meal fed. No inorganic or organic poison could be detected in either case. The samples were by no means clean—many weed seeds were present, and the sharps contained numerous

" bunt " spores ; but it was unlikely that death was in any way due to these.

No. 308.—The stomach of a hound, which had died suddenly with all the symptoms of strychnine poisoning, was analysed, and definite evidence as to the presence of the poison was obtained. The stomach was found to contain a rabbit's head, and doubtless the dog had eaten a portion of a poisoned body.

We must again emphasize the necessity of sending full information with regard to matters of this description. As a rule, no description of the symptoms observed in the affected animals is furnished. Where suspected feeding materials are sent to us it is generally the case that none of the viscera are forwarded ; and when, as occasionally happens, the interna organs are received, nothing is said about the feeding prior to death. Frequently knowledge of this kind materially aids in diagnosing the cause of death, and considerably narrows the field of search. It is, of course, quite possible for an analysis to be so conducted as to include all possible poisons, but at the present low fee of analysis it is extremely desirable that unnecessary analytical work should not be caused by leaving out any information which might throw light on the subject. A complete examination is a very tedious process and requires a great deal of attention.

SOILS.

A considerable number of soils from farms in various parts of Kent and Surrey were analysed, but it has been considered advisable to defer issuing any report upon them until next year, when a larger number of analyses can be included, and information concerning a wider area can be given.

FUNGICIDES AND INSECTICIDES.

A few samples reached us during the year, and are discussed below. It seems desirable, however, to mention here that in many cases little or nothing is known as to the nature of the active constituents of these materials, and in the absence of such knowledge it is obviously impossible to carry out

intelligent analyses. Much experimental work has yet to be performed before the fungicidal and insecticidal value of such materials can be adequately explained and analytically determined.

Liver of Sulphur.—A sample was sent for examination by a hop grower who stated that his hops had become badly scorched after spraying, and he wished to know if any injurious substance were present.

A discussion of the constituents of Liver of Sulphur and its fungicidal properties would be out of place here and will not be attempted; for information on this subject reference should be made to a paper by F. W. Foreman in the *Journal of Agricultural Science,* Vol. III., Part 4, p. 400. In this article the author proposes a method of analysis for commerical samples of Liver of Sulphur, which should yield useful information as to the purity of the material in question, and the sample received by us was examined in accordance with these suggestions. The figures obtained are given below:—

		Per cent.
Ref. 129	Free Sulphur + insoluble matter ..	1.02
	Free Alkali (soda)	4.50
	Total sulphur (precipitated) ..	39.50
	Total Alkali (soda)	34.17

Great variations in composition undoubtedly exist between the various samples on the market, and, unfortunately, at the present time hardly any data are available for the purposes of comparison; as far as could be ascertained, however, the above figures agreed well with those of genuine samples. It will be noted that the base used was sodium carbonate, and not potassium carbonate; and, as yet, little is known concerning the relative values of Livers of Sulphur manufactured from sodium and potassium carbonates respectively. The general opinion seems to be that the sodium compound can be substituted for the potassium compound, and Foreman, in the paper referred to above, comes to the conclusion that the use of soda instead of potash actually increases the fungicidal value of the product. It is noteworthy also that the material manufactured from soda is considerably cheaper than that prepared from potash. It is a well known fact that Liver of Sulphur is very liable to produce severe scorching, especially if

sprayed in hot weather or used in too concentrated a form. In this particular instance, the spraying had taken place during exceptionally hot weather, and doubtless it was to this circumstance that the damage occasioned could be ascribed.

Flowers of Sulphur.—Information as to the various forms of sulphur employed for agricultural purposes was given in the analytical report for 1910. This year only two samples were received, and both proved to be quite satisfactory.

Ref. No.	Sulphur.	Ash.	Arsenic.	Fineness.
78	99.58	.15	nil.	94.80
79	99.61	.20	nil.	94.00

Copper Sulphate.—Three samples were examined. They were finely ground, and contained in all cases between 98 per cent and 99 per cent. of copper sulphate.

Tobacco Liquid.—A sample of waste liquid from a tobacco factory was sent for analysis by a Maidstone grower. It appeared to be a simple tobacco extract, but possessed a strongly aromatic odour.

Sp. Gr.	1.018	
Water	95.80	Per cent.
Nicotine	·74	,,
Mineral matter	1.06	,,

A nicotine extract of this strength could be diluted with ten times its volume of water, and the addition of a little soft soap would be advantageous. No price was mentioned, but if the liquid were obtainable at a cheap rate it would provide an easy means of making a useful spray.

Creosotes.—Samples of this material are rarely sent us for analysis, and with the exception of those mentioned below none have been examined for several years.

The subject of timber preservation by creosoting is still much debated. Formerly much importance was attached to the amount of tar acids present, as it was considered that to them was due most of the preservative action. More recently the opinion has arisen that the non-volatile portion plays

an important part in the preservation of timber ; and, further, the value of the bases—especially acridine—is now advocated. For information as to methods of analysis and preservative value of the various constituents of Creosote reference may be made to a paper by A. D. Hall in the *Analyst*, Vol. xxiv., 1899, p. 148.

Three samples were sent in during the past session by a Farmer's Co-operative Association ; the analyses are appended together with an expert opinion on the analytical figures kindly given by Mr. H. Wilfrid Crow.

Ref. No.	Portion non-volatile at 600° F.	Tar acids.	Tar bases.
290 *a* I.	33%	4.76%	1.70%
290 *b* II.	75%	.60%	nil.
290 *c* III.	25%	9.90%	2.27%

Mr. Crow reported on these samples as follows :—

"As to pickling value, I am inclined to place them in order No. 1, No. 3, and No. 2 last. If the 9.9 per cent. of tar acids in No. 3 are of high boiling point I should be inclined to favour No. 3.

"No. 2 is not a Creosote at all in the commonly understood meaning of the name. As far as price is concerned, No. 3 would probably be the dearest and No. 2 the cheapest. For 'open' oil (oil liquid at ordinary temperatures) of about No. 1 specification, the price is about 4½d. per gallon in 40 to 42 gallon casks at the works."

The samples were all liquid at ordinary temperatures, but No. 2 was much thicker than the others, and contained an exceptionally high percentage of "heavy" or non-volatile oils. No. 3 was the thinnest and most volatile.

For technical purposes, it is usually demanded that at least 25 per cent. of non-volatile matter shall be present.

SUGAR BEET ANALYSIS 1910-1911.

By R. H. Carter and S. J. M. Auld.

The growing of sugar beet in the United Kingdom has made great strides during the last year or two, and the matter is now one of national importance. In the counties of Kent and Surrey the cultivation of the sugar beet has passed the preliminary experimental stage, and several crops have been taken during the year 1911 at the College farm, and out in the counties. The beets having been reported on after analysis in the Chemical Department of the College, it seemed desirable to put on record the results obtained, together with an account of the methods used, and those which are generally available.

Altogether sixty-two samples were analysed and reported on during the year, and of these thirty-four came from the College farm, and twenty-eight from outside sources.

In the case of the outside samples, an interpretation of the analytical results was frequently attended with some difficulty, owing to the impossibility of controlling the field-sampling of the beet, and the condition of the roots. After removal from the ground, the beet soon withers and loses some of its water content. As will be seen later, this at once causes a difficulty in the carrying out of the analysis. Again, as the moisture content decreases the percentage of sugar increases, and results are therefore obtained which are incomparable with those from fresh healthy roots. According to experiments carried out in the United States, also, the sugar content does not generally increase in proportion to the loss in weight. It is essential therefore that sugar-beets for analysis be examined as soon after lifting as possible. If the roots are kept for some time before being forwarded for analysis, the results obtained are apt to be misleading if used

as a basis for judging the suitability of a district, or the conditions of treatment for sugar beet culture.

Sampling Sugar Beets.

Field Sampling.—The obtainment of a fair sample of the beets from a plot is essential if the resultant analysis is to represent the whole crop. Special methods of sampling may be adopted whereby every tenth or so root is taken, these again similarly sub-divided until a sample of the required size is obtained, but it is generally sufficient for the grower to walk diagonally through the particular plot, and take at random average roots which are strictly representative of the whole crop. It is important that immature roots be discarded, since the sugar content continues to increase towards maturity. Specially large or small roots should also be rejected. The roots should not be broken too short, and the crown should be left intact, only the leaves being removed. Even adopting these precautions, however, small samples collected by different workers may show a difference of sugar content, for the same crop, of 2 per cent. or even more, and it is consequently desirable that the samples taken be as large as possible.

Sampling in the Laboratory.—As in most chemical analyses, the laboratory sampling of the sugar beet is of great importance since only a small quantity of material is used for the actual estimation. In the sugar-beet, also, the sugar is not evenly divided throughout the mass, but is rather more concentrated near the " bulge " of the root, and diminishes towards the crown and towards the tip. In vertical section the sugar appears in highest concentration in the zone about three-fourths of the way from the cone to the edge. This renders careful sampling necessary if the portion used is to represent the whole bulk of the field-sample. The beets as received are weighed, then washed and trimmed by removing the crowns, and weighed again. If the consignment consists of a few beets only the whole sample is grated or rasped either by hand or machinery, but with larger samples a section must be removed from each root which will represent the total. This is done by halving the beet longitudinally, or by removing

a vertical section half an inch to one inch wide, passing through the centre.

Whichever method is adopted the pulping or rasping is the same, and for this purpose, although tedious to use, we have found ordinary hand graters to be satisfactory. Mincing machines which produce a finely shredded product *without much pressure* may be used, but the usual American type of machine which feeds the material by means of a screw up against the cutting edges is unsuitable, as considerable quantities of the juice are liable to be expressed and lost from the sample. The type with rotating knives fixed on to the feeding spindle is more satisfactory, but may also cause appreciable separation of the juice. After rasping, the sample is thoroughly mixed by hand, evaporation and squeezing of the pulp being carefully avoided.

Methods for Analysis of the Sugar Beet.

For the estimation of sugar in the beet, two different types of methods are available,—the direct and the indirect. The direct method consists of extraction of the pulp, either with water or alcohol and estimation of the sugar in the solution thus obtained. It is more scientifically accurate than the indirect method whereby the beet juice is expressed, and the estimations carried out therein, but the latter gives concordant and comparative results, is much quicker and simpler to carry out, and was the method actually adopted by us.

The determinations made on the juice were :—

(1) Density, by Brix hydrometer.

(2) Sugar percentage by polarimeter.

The data thus obtained gave, both directly and by calculation, figures for (*a*) Total Solids in Juice ; (*b*) Sugar in Juice ; (*c*) Non-sugar in Juice ; (*d*) Co-efficient of Purity ; (*e*) Sugar in Beet.

Method of Estimation of Sugar in the Juice.

Expression of the Juice.—This operation was carried out by enclosing the beet pulp in calico, and expressing in a hand press. The press should be fairly powerful, and as much juice expressed from the pulp as possible, since it has been

stated that the first runnings are less rich in sugar than those obtained towards the end. The difference, however, does not appear to be very considerable, and little difficulty should occur with a moderately strong press if the beet has been finely pulped.

Total Solids in Juice.—The juice obtained by expression, as above is allowed to stand for one hour in order to remove all air bubbles, and is then transferred to a tall cylinder, and its density measured by a Brix hydrometer. It was usually found necessary to destroy the froth on the surface with a few drops of ether.

The Brix instrument is graduated to give, in direct percentages, the solids in solution (the readings being corrected for temperature according to a scale on the bulb). It is evident that for this purpose the hydrometer must be graduated for a particular solution, since a 10 per cent. solution of one substance may have a very different specific gravity from a solution of the same concentration of another substance, and the Brix hydrometer is accordingly standardized with pure sugar solutions. Beet juice, however, is by no means a pure solution of cane sugar ; impurities in the form of mineral salts, colouring matter, and nitrogenous compounds are present in addition to carbohydrate material other than sucrose. The use of this instrument can, therefore, be regarded as giving only approximately the percentage of solid matter in the juice. Nevertheless, the figures obtained possess a distinct value, and the Brix hydrometer is generally used in technical work.

Sugar in Juice.—Having measured the density by the Brix Hydrometer, the volume containing the treble normal weight of the juice is calculated or ascertained from tables (Wiley Agric. Anal. Vol. III., p. 232). The normal weight for the polarimeter used, a modified Laurent instrument by Philip Harris & Co., of Birmingham, was 16·19 grs. The weight of juice taken was accordingly 48·57 grs.

The required volume of beet juice is measured from a sucrose pipette or from a burette (using an Erdmann float) into two flasks of 100 cc. and 200 cc. capacity respectively, in order to apply, if necessary, Scheibler's correction for the volume of precipitate. To each flask is added 5 cc. of basic

lead acetate solution, the mixture well shaken and a little ether added to dispel the froth. The flasks are then filled up to the marks with distilled water.

[Basic lead acetate solution is the most satisfactory clarifying agent known, and is prepared by boiling 264 grams of yellow litharge with 464 grams of neutral lead acetate in 1,000 cc. of water for half an hour. The liquid is then allowed to cool, diluted to 2 litres, left to settle and decanted.]

The clarified solutions are filtered, the filtrates well mixed by shaking, and the sugar content estimated in the ordinary manner by polarizing in 200 mm. tubes. The polarimeter actually used by us was graduated in circular degrees and not in sugar degrees, and was previously standardized by means of solutions of pure cane sugar. The latter were chosen of such concentration that they gave approximately the same order of rotation as did the clarified beet juices.

It should be noted here that the figures obtained by direct polarization of the clarified juice in the manner described above are apt to be too high, owing to the introduction of small errors due to (1) the volume of the precipitate produced by the basic lead acetate, and (2) in some cases, to the presence of optically active substances other than sucrose which may not be completely removed by this clarifying agent. These errors are, as a rule, too small to be accounted of importance for commercial purposes. The error due to the volume of the precipitate may be corrected if necessary by the method proposed by Scheibler, in which two solutions containing the same weights of the juice (prepared according to the directions given above) are polarized. The reading obtained from the solution in the 200 cc. flask is doubled, and subtracted from that given by the 100 cc. solution. The remainder, multiplied by two, is the correction to be applied to the reading from the 100 cc. flask.

The second source of error—the presence of optically active substances other than cane sugar—is negligible for ordinary work. In the juice of healthy beets reducing sugars are practically absent. Raffinose may be present if the roots have been injured by frost, and in some seasons dextro rotatory pectin substances may occur in some quantity (Int. Cong. App. Chem., 1909, Sect. V., 47.). Polarization before

and after inversion will, if carried out with due precautions, eliminate this error (*J. Soc. Chem. Ind.*, 1911, 30, 62).

Purity of Juice.—The purity of the juice, or the co-efficient or quotient of purity, is the percentage of sugar in the solids of the juice, and is obtained by multiplying the percentage of sugar in the juice by 100 and dividing by the percentage of total solids in the same juice.

By many people this factor of the "purity" of the juice is regarded as one of the most important factors determinable by beet analysis.

Sugar in Beet.—From the percentage of sugar in the juice the amount of sugar in the beet is determined by means of a factor. This factor is a correction for the amount of "marc" or cellular matter existing in the beet, and is liable to a certain amount of variation. According to Wiley the beet is 95 per cent. juice and 5 per cent. "marc" and the factor should therefore be 0.95, but there are considerable variations for different districts and conditions of the beet. For a particular locality or series of consignments of roots, the factor should be determined from beets of average quality by dividing the percentage of sugar in the beet (as determined by an extraction method) by the percentage of sugar in the juice. This factor will then be available for all similar beets of like condition. The factor used by us was 0.94.

Advantages of the Indirect Method of Analysis.

The extensive use of the indirect method lies in the following advantages :—

(1) It is extremely rapid, and this is a matter of importance in sugar beet analysis, where numerous determinations have to be carried out.

(2) Large quantities of pulp, representing many beets, may be used for expression, and an average sample is consequently more easily obtained.

(3) Besides the actual amount of sugar, the purity of the juice and the amount of solids not sugar present in the juice are determined.

Objections to the Indirect Method.

The chief objection to the method of expression is the fact that the sugar in the beet is determined by means of a factor which may vary considerably in extent. It is impossible accurately to gauge the amount of actual juice present in the beet; and the determination of the "marc" and the subtraction of this from 100 will not give an absolutely correct figure. Even by determination of the factor as described above, one is left with the assumption that all the beets from a particular district or series of samples are of the same condition. This is not likely correctly to represent the true state of affairs.

Sugar Beet Analyses.

The results obtained by us by the indirect or expression method have been quite concordant and satisfactory, and only for more scientific work do we suggest the adoption of one of the direct or "diffusion" methods. Indeed we have come to the conclusion that for commercial valuation the possible maximum errors due to the indirect method are almost negligible by the side of the possible variations in samples drawn from the same crop and taken as representing the whole. As already mentioned, this variation in sugar content may amount to 2 or 3 or even 4 per cent. (*Cf.* Bull. 146, Bur. of Chem., U.S. Dept. of Agric.), and this is borne out by the following individual analyses of a consignment of ten beets composing one sample sent to the College:—

Weight of Roots.		Sugar in Roots. Per cent.
757 grams	..	14.78
845 ,,	..	13.99
881 ,,	..	14.08
957 ,,	..	14.66
1004 ,,	..	16.75
1046 ,,	..	15.38
1085 ,,	..	13.95
1098 ,,	..	13.69
1109 ,,	..	12.09
1166 ,,	..	14.87

Table V.

Sugar Beet Analysis.

S.E.A.C. Samples.

Reference.	Total solids apparent in Juice. Per cent Brix.	Sugar in Juice. Per cent.	Non-Sugar (app.) in Juice. Per cent.	Coefficient of Purity.	Sugar in Beet. Per cent.
Ridges 22″	18.1	13.71	4.39	75.73	12.93
Flat 22″	20.27	17.51	2.76	86.50	16.53
Flat 15″	22.4	19.47	2.93	86.94	18.39
Flat 18½″	22.4	23.80	2.02	9.99	19.24
5 A 20lbs. seed	20.4	17.50	2.90	85.76	16.51
5 B 15lbs. seed	22.60	19.54	3.06	86.50	18.45
5 C 10lbs seed	22.95	19.97	2.99	87.04	18.86
Braune's Kleinwanzleben Elite	22.2	19.40	2.80	87.38	18.31
Willy Mette's Klein Wanzleben Ideal	21.80	18.47	3.33	84.70	17.44
Dippe Bros. W.I.	20.9	18.01	2.89	86.18	17.01
Brenstedt's Elite	18.6	15.16	3.44	81.51	14.31
Aderstedter Original	19.5	16.07	3.43	82.39	15.17
Aderstedter Original Geshalt und desenfiziert	20.40	16.71	3.69	81.93	15.78
Strubesche Zucker rubensamen	22.50	19.09	3.41	84.84	18.03
Manurial A	20.50	17.87	2.63	87.18	16.88
,, B	21.70	18.06	3.64	83.24	17.06
,, C	22.80	19.97	2.83	87.62	18.86
,, D	21.20	19.42	1.78	91.60	18.33
,, E	22.70	19.16	3.54	84.43	18.09
,, F	19.95	17.94	2.01	89.89	16.93
,, G	21.40	18.34	3.06	85.69	17.31
,, H	20.30	16.97	3.33	83.26	15.95
,, Z	22.0	19.13	2.70	87.70	18.22
,, Y	21.8	19.01	2.79	87.18	17.95
,, X	21.3	18.96	2.34	89.02	17.90
,, W	22.50	19.78	2.72	87.92	18.67
,, V	22.40	19.32	3.08	86.28	18.24
,, U	22.00	18.32	3.68	83.28	17.30
,, T	21.90	18.97	2.93	86.64	17.91
,, S	21.50	17.45	4.05	81.16	16.47
College					
Over 3lbs.	20.86	17.40	3.46	83.39	16.43
Over 2lbs.	20.71	17.80	2.91	85.96	16.81
Under 2lbs.	20.0	16.90	3.10	84.50	15.95

Sugar Beet Analysis.

Other Samples.

		Total solids in Juice. Per cent.	Sugar in Juice. Per cent.	Non-Sugar in Juice. Per cent.	Coefficient of Purity.	Sugar in Beet. Per cent.
172		21.69	18.51	3.09	85.69	17.48
		21.35	19.18	2.17	89.82	18.10
		21.60	19.66	1.94	91.01	18.57
		19.60	15.46	4.14	78.86	14.60
		20.45	16.89	3.56	82.60	15.95
		20.10	17.48	2.62	86.96	16.50
		23.00	19.14	3.86	83.22	18.07
		21.40	18.64	2.76	87.10	17.60
		22.60	20.04	2.56	88.65	18.91
		19.48	16.24	3.24	83.37	15.33
		23.00	19.98	3.02	86.90	18.87
		22.20	19.34	2.86	87.12	18.26
		16.80	12.18	4.62	72.49	11.50
		19.20	16.50	2.70	85.94	15.58
		22.00	18.57	3.43	84.41	17.53
		19.00	15.59	3.41	82.04	14.72
		18.85	15.36	3.49	81.47	14.50
		22.30	19.89	2.41	89.21	18.78
178	a	20.30	17.56	2.74	86.52	16.68
	b	22.00	19.11	2.89	86.88	18.16
	c	20.80	17.36	3.44	83.45	16.49
181		18.30	15.53	2.77	84.84	14.66
187	a	16.80	13.64	3.16	81.19	12.87
	b	10.70	6.42	4.28	60.03	6.06
	c	17.40	13.83	3.57	79.49	13.05
	d	17.80	13.38	4.42	75.13	12.63
210		19.50	16.20	3.30	83.10	15.30
234		28.40	24.52	3.88	86.36	23.15

The College samples were drawn from experimental plots laid out under a scheme provided by the Board of Agriculture, and full information concerning the treatment of the land, varieties of roots, etc., will be found on page 28.

Of the other samples analysed, those corresponding to Ref. No. 172 were sent in by S. Mendel, Esq., of Maidstone. The remaining samples were received from individual growers.

Nos. 178 a, b, and, were grown at Ripley, Surrey, on three different farms; each sample comprised five roots.

178a contained large roots, rather badly fanged. The proportion of crown was excessive. Average weight of washed and trimmed roots 1lb. $15\frac{1}{2}$ozs.

178b. The roots were of fairly good shape, and had grown well in the ground. Consequently the proportion of crown was small. Average weight of washed and trimmed roots 1lb. $4\frac{2}{3}$ozs.

178c. Well shaped roots; too much crown. Average weight 1lb. $4\frac{3}{4}$ozs.

Nos. 187a, b, c, d. Four samples from Doddington, near Sittingbourne; three roots per sample. These were of distinctly poor quality compared with the other beets examined, and the samples in themselves were very uneven, consisting of roots varying greatly in size. For this reason it was not possible to obtain an average weight for the individual roots, and each sample, after washing and trimming, was consequently weighed as a whole. A communication received from the grower some time after the analyses had been completed stated that the crop had suffered severely from drought.

187a. (Wanzleben.) This was the best of the four as regards both shape and purity. The sample consisted of two large roots, and one small, twisted root. Weight of sample 4lbs. 5ozs.

187b. (Danish Improved.) These roots could not be regarded as true sugar beets either in appearance or composition. In shape they resembled long red mangolds, and possibly the variety was similar to that of the so-called sugar mangold. Weight 6lbs. 1oz.

187c. (Improved Imperial.) A very uneven, fanged sample, with excessive proportion of crown. Weight 2lbs. 15ozs.

187d. (Wanzleben). This sample was also composed of badly shaped roots of very varying sizes. Weight 3lbs. 5ozs.

Sample No. 234 was received late in January, and consisted of three small, very shrivelled roots. There is no doubt whatever that these beets had lost a considerable quantity of water by evaporation before arrival at the College, resulting in an increased concentration of sugar in the juice. It will be seen from the table that the percentage of sugar in the roots was exceptionally high.

THE PHOSPHOMOLYBDATE ESTIMATION OF PHOSPHORIC ACID IN SOILS.*

BY

S. J. M. AULD, D.Sc.

The estimation of very small quantities of phosphoric acid, as for example in the "citric soluble" extract of soils has led to the adoption of many methods of using the bulky ammonium phosphomolybdate precipitate direct, instead of precipitating its ammoniacal solution with magnesia mixture. The composition of the precipitate itself, prepared under standard conditions, although definitely found to have the constant ratio of $P_2O_5 : MoO_3 : = 1 : 24$, varies according to different people in the amount of ammonia and of water present.

Carnot's method of estimation by weighing the reprecipitated yellow compound after drying at 100° C. has been found to yield rather varying results, and, if employed, the factor used in calculating the results should be 0.0378 as against the 0.037 recommended by him and calculated from a fully-hydrated formula.

Many different factors and methods of treatment exist in the usually adopted type of method, whereby the phosphomolybdate precipitate is dissolved in ammonia and evaporated to dryness. These methods apparently frequently depend on an assumed stability of the combined ammonia, which does not actually exist.

The usual method (Hall, "The Soil," p. 146) consists of heating the ammoniacal solution gently over an Argand burner, the residue becoming partly blue, and using the

* Abstract of a paper read before the Society of Public Analysts, March 6th, 1912.

factor 0.03794. In this method and others of the same type, it has been found impossible to control the coloration to any particular stage co-incident with the removal of the extraneous ammonium salts. It would seem that either a wholly yellow or a wholly blue residue should be obtained.

That one is not so likely to obtain a uniform product by dissolution in ammonia may be judged from a consideration of the reactions involved. On solution in ammonia the yellow precipitate is probably largely resolved into ammonium molybdate and ammonium phosphate but may, at any rate partially, involve the formation of ammoniun phosphopentamolybdate and Debray's duodecaphosphomolybdate. Since ammonium phosphate loses ammonia on heating and ammonium molybdate is partially reduced to the blue oxide $Mo_3 O_8$, it is difficult to see how a satisfactory product for weighing can be obtained by heating at 100° C. or by partial ignition.

In agreement with these considerations it has been found that on heating the usual "partially blue" residues to complete blueness, different percentage losses of weight occur although the blue residues become of practically constant weight by heating over the Bunsen flame. Experiments carried out with N/5 sodium phosphate solution show that the percentage of P_2O_5 in the ordinary residues varies considerably and more constant results are obtained by heating until a uniform blue product is obtained. The experiments were controlled by examination of a large number of residues obtained during the analysis of soils in the College laboratories.

In order to avoid the complications resulting from the solution of the ammonium phosphomolybdate, the following method was eventually adopted and has been found to give extremely uniform results if carefully carried out.

Method Recommended.

The yellow precipitate obtained in the ordinary way is dissolved in dilute ammonia, the solution filtered from impurities and then re-precipitated by the addition of nitric acid (1 to 2). A further 5 cc. or so of ammonium molybdate

solution are added to the mixture, which is then allowed to stand in a warm place as in the first precipitation.

The precipitate thus obtained is of a fine consistency and may be filtered with ease and rapidity through asbestos in a Gooch crucible. It is washed thoroughly with 1 per cent. nitric acid, dried in the water oven and then ignited over a fairly strong Bunsen flame until of a uniform dark blue colour and of constant weight. Care must be taken to prevent the flame from entering the crucible and causing reduction, and the base of the Gooch crucible should be protected with a cap.

From the mean of a large number of experiments carried out by this method with standard sodium phosphate solutions, the average factor obtained was found to be 0.0396.

It is interesting to note that this percentage of P_2O_5 in the residue (3.96) does not correspond to phosphomolybdic acid, but to a partial reduction corresponding to the formula P_2O_5, Mo_3O_8, .21 MoO_3. This is also more in agreement with the blue colour which is produced.

THE FORMATION OF PRUSSIC ACID FROM LINSEED CAKE AND OTHER FEEDING STUFFS.

By S. J. M. Auld, D.Sc. (Lond.), Ph.D., F.I.C.

A considerable amount of attention has been paid in recent years to the formation of hydrocyanic acid in plants, both from an economic and from a plant physiological point of view. Since a number of these plants are used as feeding stuffs, both in this country and abroad, the matter has assumed considerable importance with regard to the welfare of stock fed on such material, and has rendered it necessary that the amounts and conditions of the formation of prussic acid should be thoroughly examined.

In all the plants and plant products so far investigated the prussic acid has been shown to be formed by the hydrolysis of a glucoside by a co-existent specific enzyme. The oldest known example of this type of reaction is the production of prussic acid from bitter almonds, which is caused by the decomposition of the glucoside *amygdalin* by the enzyme *emulsin*—benzaldehyde, hydrocyanic acid and two molecules of dextrose being the final products formed:

$$C_{20}H_{27}NO_{11} + 2H_2O = HCN + C_6H_5.CHO + 2C_6H_{12}O_6$$

In the last decade a number of other glucosides of this type have been isolated, of which the following are the most important:—

Glucoside.	Source.	Investigators.
Lotusin	*Lotus arabicus*	Dunstan and Henry.[1]
Dhurrin	*Sorghum vulgare* (Great millet)	,, ,,
Phaseolunatin	*Phaseolus lunatus* (Java beans)	,, ,,
	Manihot utillisima (Cassava)	Dunstan, Henry & Auld.[2]
	Linum usitatissimum (Flax or linseed)	,, ,,
Gynocardin	*Gynocardia odorata*	Power & Gornall.[8]
Vicianin	Vetch Seeds	Bertram.[12]

In each case when the ground plant or seed is placed in water the contained glucoside is hydrolysed with the formation of hydrocyanic acid. The terms "cyanogenesis" and "cyanophorism" have been variously ascribed to this phenomenon by Dunstan and by Armstrong.

The question of cyanogenesis became of particular and immediate importance several years back, owing to the importation into this country of large quantities of Java beans which were used as a feeding stuff, and which caused the death of numerous animals throughout the United Kingdom. The potential prussic acid content of these beans was found to vary from 0.038 per cent. up to a maximum of 0.123 per cent. and their poisonous character was very marked.

Owing to the amount of attention drawn to the subject, the importation and use of the "Java beans" has apparently ceased, but the experience has left behind it a suspicion, which has tended to increase, of other feeding stuffs which contain cyanogenetic glucosides, and notably of linseed and linseed cake.

Cyanogenesis in Linseed.

It was first shown by Jorissen, in 1883, that linseed is capable of yielding hydrocyanic acid. The same author in conjunction with Hairs subsequently isolated from linseed a cyanogenetic glucoside which he called linamarin[9], and which the present author in association with Dunstan and Henry[2] showed to be identical with the phaseolunatin of Java beans. On maceration with water the glucoside is decomposed with the formation of dextrose, prussic acid and acetone as follows:

$$C_{10}H_{17}NO_6 + H_2O = C_6H_{12}O_6 + CH_3.CO.CH_3 + HCN$$

Although it was established so long ago as 1883 that linseed is capable of yielding appreciable quantities of hydrocyanic acid, the fact was apparently little known, or its practical importance not realized, until Henry and Auld[4], in 1908, pointed out that linseed cake, consisting merely of crushed flax seed freed from oil, must be capable of extensive cyanogenesis. On examining a number of linseed cakes the authors actually found them to contain considerable quantities of the glucoside phaseolunatin, and offered as an explanation of the generally assumed non-poisonous character of linseed cake

that during the process of hot expression of the oil, the enzyme is completely destroyed by the high temperature, so that when the cake is eaten by stock no decomposition of the glucoside occurs in the stomach. Two samples of cake quoted yielded respectively 0.032 and 0.045 per cent. of prussic acid on distillation of their extracts with sulphuric acid, but no prussic acid was liberated when the cakes were ground and placed in water.

This, however, is not the general rule, and later experience has shown that although in some cases prussic acid is not liberated from the glucoside present in the cake, the majority of linseed cakes will furnish at any rate a proportion of their hydrocyanic acid on soaking in water. Indeed, of the large number of oil cakes examined by the author during the past year only a few were found to give no hydrocyanic acid on soaking with water, and allowing to stand. This may possibly be due to the increased adoption of oil-presses of the Anderson type which press linseed in the cold, or at any rate the use of a lower temperature during pressing, whereby some, at least, of the glucosidoclastic enzyme escapes destruction. It is noteworthy, however, that in no case was a diminished rate of formation of prussic acid noted in cakes of lower oil content, which might be assumed to have been pressed at a higher temperature or kept under the influence of heat for a longer period.

Quantity of Prussic Acid produced from Linseed Cake.

Besides the figures quoted above, results have been put on record by Smetham[5], who obtained 0.017 per cent. prussic acid, Dyer (Discussion on Henry and Auld's paper, *loc. cit.*), who quoted one cake which gave the large quantity of 0.06 per cent. HCN on distillation with acid, and about one-third of that quantity on soaking in water for thirty-six hours, and by Lander. The last-named author found a maximum of 0.026 per cent. of free or " available " prussic acid in the cakes examined by him, but quotes a sample analysed by Voelcker which gave 0.051 per cent. HCN.

In the large number of linseed and linseed-containing cakes examined during the present investigation, the content of free prussic acid was found to vary from 0.001 per cent.

up to 0.052 per cent. The latter figure, the highest obtained by the author, was obtained after six hours by soaking the cake in water at 38° C. This quantity is equivalent to 3.9 grains of prussic acid per lb.

Little evidence exists as to the lethal dose of prussic acid for animals. Lander (*loc. cit.*) found a dose of potassium cyanide equivalent to 30 grains of prussic acid necessary to cause the death of a heifer (six months), but this quantity seems rather excessive, particularly in view of the deaths which have occurred amongst full grown cattle through eating comparatively small quantities of Java beans.

The minimum lethal dose for a man is usually placed at one grain, but to give a margin for individual cases may be taken as two grains for a man weighing 160lbs. If for animals the lethal dose is, weight for weight, the same as in man, this would mean a lethal dose of 1.5 grains for a sheep (120lbs.) and 7.5 grains for a calf (600lbs.), or only slightly more than $\frac{1}{3}$-lb. of the 0.052 per cent. HCN cake for the sheep and 2lbs. for the calf.

It would thus seem that the (assumed) lethal doses for the various animals might be easily reached if the prussic acid is formed during mastication and digestion to the same extent to which it is formed on soaking with warm water.

The present investigation was divided therefore into two main branches in order to find, if possible, (*a*) the conditions under which cake containing " free " hydrocyanic acid (*i.e.*, both cyanogenetic glucoside and active enzyme) might prove dangerous to stock, and (*b*) whether the glucoside may be hydrolysed by ferments in the animals' digestive tract, or by ferments added extraneously in other food and so render dangerous cake which only contains " potential " hydrocyanic acid (*i.e.*, cyanogenetic glucoside alone).

Poisoning by Linseed Cake.

Poisoning by Linseed Cake has been known to occur in many cases and has frequently been put on record. Linseed cake is, however, generally regarded as one of the safest and most wholesome foods the farmer can use, and cases of death, which may possibly have been due to prussic acid formation, have generally been explained away as due to the presence of castor seed cake or husk, or to some obscure disease, etc.

On the other hand, since the question of prussic acid formation has attained a more general interest there has been rather a tendency in some quarters to attribute the death of stock receiving even a small ration of linseed cake, to cyanogenesis. In some cases "scare" head lines in the papers and an undue amount of attention to the subject have been the result, the effect being to prejudice the use of what may have been a perfectly harmless food stuff. Until the matter has been thoroughly threshed out, this course of action on the part of analysts and others is to be deprecated, and until every other possible cause of death has been eliminated, poisoning by prussic acid generation should not be made too much of. This course has been adopted, for example, by Smetham[5], who refused, in the light of existent knowledge, to condemn a linseed cake furnishing 0.017 per cent. of HCN which had been fed to calves which died.

Analytical Methods.

Total Prussic Acid.

This figure, representing the amount of cyanogenetic glucoside present in the cake or other feeding stuff, was determined by a modification of the method described by Henry and Auld (*loc. cit.*) as follows:—A known weight (about 25 grs.) of the ground material is re-percolated with hot alcohol in a Soxhlet extractor for twenty-four hours. The solvent is then distilled off from the extract, a little water is added, and then sufficient 10 per cent. sulphuric acid to bring the concentration of the acid roughly to 6 per cent., the total volume being about 50 c.c. The mixture is then distilled until no more prussic acid is liberated, the end of the condenser passing under the surface of dilute caustic soda contained in the receiving flask. The distillate is then titrated, according to Liebig's method, with standard silver nitrate solution. The water in the distilling flask is replenished from a tap-funnel as required.

The 6 per cent. sulphuric acid used is much preferable to the 2 per cent. acid previously recommended (*loc. cit.*) since the distillation, which is usually rather tedious, is greatly expedited thereby. There is no loss of HCN caused by its use, as was

proved by a series of experiments carried out both with amygdalin and with linseed extracts. Indeed 8 per cent. acid gave theoretical results also, at least in the former case. There is, however, rather more carbonisation of the cake extract when the stronger acid is used, with a consequent possibility of sulphur dioxide being formed, and finding its way to the distillate. This, however, has no effect on the subsequent titration. A series of estimations was carried out in which a solution of potassium cyanide ($^N/_2$) was mixed with increasing quantities of normal sodium sulphite and titrated in the ordinary manner. In quantities up to 77 per cent. of the HCN titrated the sodium sulphite had absolutely no effect.

"*Free*" *Prussic Acid.*

The prussic acid liberated when the finely ground linseed-cake or other feeding stuff is soaked with water was estimated in the following manner: About 250 c.c. of water are placed in a round bottomed long-neck flask of about $1\frac{1}{2}$ litres capacity, a few drops of toluene added, and the liquid brought to the experimental temperature by immersion in a thermostat. A weighed quantity of the finely-ground cake, varying from 25 to 50 grs. according to circumstances, is then introduced into the flask, mixed by giving the contents a shake, and the flask then stoppered with a rubber bung and placed in the thermostat. If the water is added to the cake, instead of *vice versa*, the material is apt to clog and not become thoroughly wetted.

When the action has ceased (twelve hours is sufficient at a temperature of 38°C.) the contents of the flask are steam distilled into saturated sodium bi-carbonate solution and the prussic acid content of the distillate determined by titration with $^N/_{50}$ iodine solution (Henry and Auld, *loc. cit.*). This method is much more satisfactory for these distillates than the silver nitrate titration method, since reducing substances, which interfere with the end point, are apt to be present in the distillates.

In cases where the reaction had to be stopped at a definite time, various expedients were used to stop the enzyme activity. If the estimation could be carried out at once the

current of live steam for the distillation was sufficient almost immediately to prevent further hydrolysis. If it was necessary to place the flasks on one side for a time a few c.c.s of 20 per cent. caustic soda were most effective for inhibiting the reaction. Sodium bicarbonate causes undue frothing during the subsequent distillation and mercuric chloride solution also did not give satisfactory results.

Analysis of Cakes from Different Sources.

A large number of linseed and linseed-containing cakes of different origins were examined with regard to their content of cyanogenetic glucoside and of "free" hydrocyanic acid. Contrary to expectations, very few cakes were found in which no free prussic acid existed, *i.e.*, in which all the enzyme had been destroyed. The maximum amounts of prussic acid also were obtained from two genuine 95 per cent. English linseed cakes. Unlike the Calcutta cake examined by Voelcker (*vid. sup.*), stock showed no objection to eating these cakes, at any rate when fed in the dry state.

The results obtained from a number of typical cakes are quoted in Table I., p. 296.

Rate of Formation of Prussic Acid from Linseed Cakes.

The formation of prussic acid from the linseed cakes varies considerably in velocity with different cakes, especially in the preliminary stages, implying the presence of different quantities of active enzyme. The most remarkable point noted was the great rapidity with which the hydrogen cyanide is formed in the early stages, particularly when kept at temperatures approximating to blood-heat. Half of the available prussic acid is frequently liberated in fifteen minutes and the maximum is practically reached within six hours and sometimes in considerably less time.

Most of the experiments were carried out with the cakes L and S (See Table I.).

TABLE I.

PRUSSIC ACID CONTENT OF LINSEED CAKES.

Reference.	Description.	"Total" HCN.	"Free" HCN.*	Remarks.
A1	English Linseed Cake	0·023	0·013	
B1	,, ,,	0·026	0·011	
C1	,, ,,	0·041	0·020	
E	Russian Linseed Cake	0·033	traces	
F	,, ,,	0·033	0·013	Source—Riga. Much chaff and cereal straw present.
H	,, ,,	0·046	0·018	
I	,, ,,	0·035	0·020	
J	Spanish Linseed Cake	—	0·044	
L	English Linseed Cake	0·050	0·042	12% oil.
S	,, ,,	0·056	0·052	9% oil.
K	Italian Linseed Cake	0·022	0·010	Very soft cake, 14% oil.
L3	Hamburg Linseed Cake	0·035	0·029	
D1	English "Oil Cake"	0·040	—	
D2	Russian "Oil Cake"	0·029	0·013	Chiefly linseed.
D3	"Oil Cake"	—	0·009	Origin unknown, chiefly Niger seed.

* 24 hours at 38°C.

Table II.

Velocity of Formation of HCN. from Linseed Cake.
(L. 12 per cent. Oil.) Temp. = 38. 5°C.

Weight of Cake used. grams.	Time of Digestion.	HCN formed. grams.	HCN Formed. per cent.	Total Glucoside Decomposed. per cent.
50	nil*	0·00032	0·00064	—
50	5 min.	0·00425	0·0085	17·0
25	10 ,,	0·00376	0·015	30·0
25	15 ,,	0·00549	0·022	44·0
25	30 ,,	0·00650	0·026	52·0
25	1 hour	0·00742	0·030	60·0
25	3 ,,	0·00900	0·036	72·0
25	6 ,,	0·01013	0·040	80·0
50	12 ,,	0·02075	0·0415	83·0
25	24 ,,	0·01061	0·042	84·0
50	48 ,,	0·02100	0·042	84·00

Effect of Temperature.

The effect of temperature on the rate of hydrolysis of phaseolunatin present in linseed cake is most marked and, of course, has a practical bearing with regard to the temperature at which linseed cake gruel, etc., may be made.

The results of the experiments quoted in Tables II., III. and IV. (see pp. 297, 299, 300) are plotted graphically in the accompanying curves (Fig. 1.), which serve better to illustrate the velocities of formation of the prussic acid in each case.

* Estimated by quickly adding the cake to water just short of boiling (about 95°C.) and steam distilling at once.

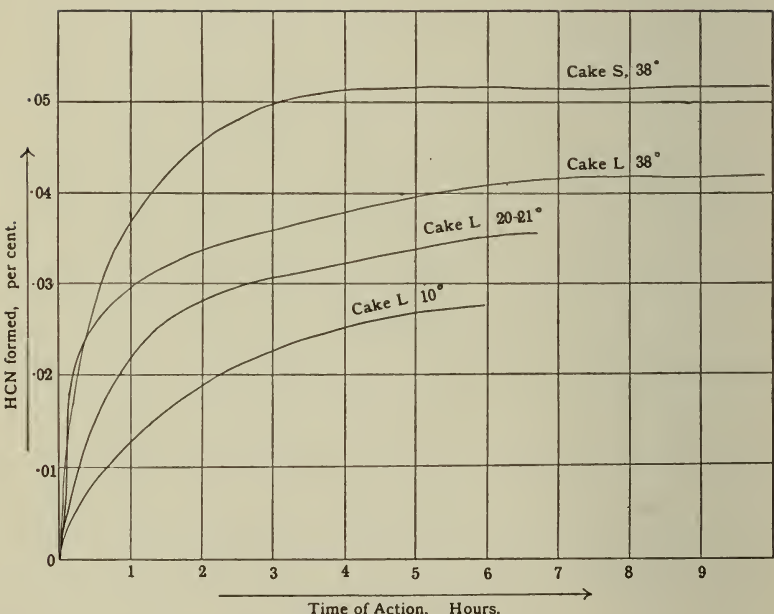


Fig 1. Formation of Hydrocyanic Acid from Linseed Cake.

TABLE III.

VELOCITY OF FORMATION OF HCN FROM LINSEED CAKE.
(S. 9 per cent. Oil) Temp. = 38°C.
25 grs. of Cake used in each Experiment.

Time of Digestion	HCN formed grams.	HCN formed per cent.	Total Glucoside decomposed per cent.
5 min.	0·00268	0·00107	19·1
10 ,,	0·00372	0·0149	26·6
15 ,,	0·00440	0·0176	31·4
30 ,,	0·00662	0·0265	47·3
1 hour	0·00942	0·0377	67·3
2 hours	0·01160	0·0464	82·8
3 ,,	0·01250	0·0500	89·2
6 ,,	0·01287	0·0515	91·0
12 ,,	0·01300	0·0520	91·5

PREPARATION OF LINSEED CAKE FOR STOCK.

As a rule linseed cake is not fed to stock in the moist condition unless as a gruel for calves. When fed dry there is no danger of prussic acid being formed previous to feeding, and the conditions prevailing in the digestive tract are very diverse and will be considered later.

Preparation of Linseed Cake Gruel.

It will be gathered from the previous experiments that a gruel improperly made with cold, luke-warm or even with hot water, and allowed to stand (and incidentally to cool) is liable to contain practically all the "available" prussic acid of the cake, unless the temperature is so high that all the enzyme is destroyed. Even a small quantity of active enzyme remaining will be capable, in time, of hydrolysing the greater part of the glucoside, and the loss on standing, by volatilization, of prussic acid from a linseed gruel is comparatively small at low temperatures.

TABLE IV. CAKE L.

25 grs. of Cake for each Experiment.

Temperature of Action.	Time of Digestion.	HCN formed. grams.	HCN formed. per cent.	Total Glucoside decomposed. per cent.
10° C.	5 mins.	0·00130	0·0052	10·4
,,	10 ,,	0·00165	0·0066	13·2
,,	15 ,,	0·00192	0·0077	15·4
,,	30 ,,	0·00252	0·0101	20·2
,,	1 hour	0·00357	0·0143	28·6
,,	2 hours	0·00490	0·0196	39·2
,,	3 ,,	0·00582	0·0233	46·6
,,	6 ,,	0·00675	0·0270	54·0
Laboratory Temperature 20—21° C.	5 mins.	0·00165	0·0066	13·2
	10 ,,	0·00202	0·0081	16·2
	15 ,,	0·00279	0·0111	22·2
	30 ,,	0·00391	0·0156	31·2
	80 ,,	0·00642	0·0256	51·2
	3 hours	0·00795	0·0318	63·6
	6 ,,	0·00894	0·0358	71·6
38·5°C	See	Table II.		

In this connection some remarks by Smetham (*loc. cit.*) are of interest. He writes " . . . . if Linseed or Linseed Cake Meal is used in the preparation of a calf meal and is mixed into a gruel with water which does not approach the boiling point, and is allowed to stand for a considerable time before use, a grave danger will be run."

Two methods of preparing calf gruel with boiling water are in general use. The meal is either thoroughly mixed with boiling water and then diluted with water or skim-milk

to the required temperature, or else a larger quantity of boiling water is used and the mixture allowed to stand, covered over with a sack or other cloth, in a warm place for a number of hours and then fed. The latter method gives better gruels, and by maintaining a high temperature for a considerable time is more likely completely to destroy the enzyme.

In one experiment 25 grs. of the powdered cake were mixed with boiling water and then diluted with cold water (about 250 cc.) to 38° C. After standing at this temperature for fifteen minutes the amount of prussic acid generated was found to be 0.0027 per cent.

A gruel was then prepared as for practical purposes as follows: 8-ozs. of linseed cake meal (Cake S.) were thoroughly mixed by stirring with two quarts of boiling water, the containing vessel covered over and allowed to stand in a warm place. The temperature of the mixture was noted at intervals, and after it had fallen to 55° C., at which temperature any undecomposed enzyme might be supposed to possess an appreciable activity, a series of estimations of prussic acid was made extending over seven hours. The temperature of the mixture was maintained at over 80° C. for about forty minutes. The results given below show conclusively that a gruel properly made (in this way) with boiling water will not generate prussic acid even after standing indefinitely before feeding, and that the enzyme may be supposed to be completely destroyed by the action of the heat (Table V., p. 302.)

Within the limits of experimental error due to difficulty of sampling these figures may be regarded as constant, and the amount of prussic acid formed as negligible.

Effect of other Feeding Stuffs, etc., on the Formation of Prussic Acid from Linseed.

Phaseolunatase.—The specific enzyme of the cyanogenetic glucoside of linseed occasionally occurs in nature apart from the glucoside. Apparently it may occur in small quantities in some samples of emulsin [3, 6] and doubtless exists in ordinary brewers' yeast, since the latter material effects a resolution of phaseolunatin incommensurable with the small amount of emulsin present.[11]

TABLE V.

PRUSSIC ACID PRODUCED FROM A LINSEED GRUEL.

Quantities of material as mentioned above :—

Time of Standing.	Temperature. Degrees C.	Prussic Acid formed. per cent.
—	95	—
40 mins.	80	—
70 ,,	57	0·0033
2 hours	45	0·0035
3 ,,	35	0·0021
4 ,,	32	0·0020
8 ,,	15	0·0021

There is therefore a possibility of other materials, fed together with linseed cake, containing the same enzyme and thus, in effect, transforming a safe enzyme-free cake into a prussic-acid-containing one, or else by increasing the existing enzyme content of the feed hastening the rate of evolution of hydrocyanic acid and thereby increasing its relative toxicity to the animal.

This may possibly be the case with substances liable to contain yeast cells such as brewers' and distillers' residues or mouldy and partially fermented feeds and also with the green fodders, etc., some of which are known to contain glucosidoclastic enzymes.

EFFECT OF YEAST AND YEAST-CONTAINING FEEDS.

The effect of yeast on isolated phaseolunatin is much more marked if the yeast itself is used instead of an extract. In a preliminary experiment 10 c.c. of a 20 per cent. yeast cream decomposed .0504 gr. of glucoside or 48 per cent. in nineteen hours. The yeast is also capable of producing HCN from a cake containing no "free" prussic acid.

The increased action in the case of a cake containing available hydrocyanic acid may be gathered from the results

tabulated below. The yeast cream for the experiments was prepared by macerating 100 grs. of ordinary brewers' yeast with 250 c.c. of water. The thin paste was sterilized with a few drops of toluene, and shaken continuously at 38° C. for a few hours previous to use. In each case 25 grams of linseed cake were used.

TABLE VI.

Time of Action. mins.	With Yeast.			Without Yeast.	
	Volume of Yeast Cream. cc.	HCN. formed. grams.	HCN. formed per cent.	HCN. formed. grams.	HCN. formed. per cent.
10	10	0·00537	0·0215	0·00370	0·0184
15	10	0·00655	0·0262	0·00490	0·0196
	20	0·00648	0·0259	0·00490	0·0196
	40	0·00670	0·2068	0·00490	0·0196
30	10	0·00900	0·0360	0·00800	0·0320

Brewery and Distillery Waste Products.

Brewers' grains, the waste product left from the mash, were examined for the presence of yeast. The samples examined, however, contained none, and in agreement with this no increased formation of HCN took place when the grains and the linseed cake were incubated together in the moist condition. Moist grains, however, readily become sour and mouldy, and in this condition might be distinctly injurious, as many of the commoner moulds are capable of effecting the hydrolysis of cyanogenetic glucosides.

Distillery waste, the residue left after alcoholic fermentation of the washed grain and removal of the alcohol, is more likely to contain yeast residues. Unfortunately samples of the fresh material could not be obtained, and no results are therefore available. It is desirable, however, that this point be elucidated.

Influence of Green Fodders on the Formation of Prussic Acid.

A large number of green fodders, likely to be fed with linseed cake, were examined in order to determine whether they were capable of producing hydrocyanic acid from it. The plants chosen do not represent the whole range of fodders available, but were decided upon as being characteristic green-feeds, as in the case of rye and lucerne, or because they were known or asserted to contain glucosidoclastic or sucroclastic enzymes, as in the case of maize and the kidney vetch.

Most of the fodders were grown specially for the purpose. The green plants were carefully dried at ordinary temperature, disintegrated and then reduced to a powder in the mill. In each case experiments were carried out both with the powdered plant and with extracts prepared from it. Control experiments were also carried out to test the activity of the plant extracts towards amygdalin, phaseolunatin and other glucosides. In some cases, such as that of *Secale cereale*, these gave positive results, but having less bearing on the immediate question than the total effect on linseed cyanogenesis, are reserved for a separate report.

Common Rye. Secale cereale L.—Cut just before flowering. The extract was prepared by digesting the ground material with 12 volumes of water containing a few drops of toluene for 48 hours at 38°C.

Temp. = 38·6°C.

25 grs. cake + 50 cc. extract in 30 mins. gave 0.032 per cent. HCN.

25 grs. cake + 15 grs. ground plant in 30 mins. gave 0.022 per cent HCN.

25 grs. cake alone in 30 mins. gave 0.030 per cent. HCN.

Lucerne. Medicago sativa L.—Cut at the stage with flowers unopened. Extract prepared as above.

Temp. = 37.5°C.

25 grs. cake + 100 cc. extract in 30 mins. gave 0.030 per cent. HCN.

25 grs. cake + 20 grs. ground plant gave 0.026 per cent HCN.

25 grs. cake alone in 30 mins. gave 0.031 per cent. HCN

Common Vetch or Tares. (Variety winter.) *Vicia sativa L.* —Cut in full flower. Extract prepared as before.

Temp. = 37.0°C.

25 grs. cake + 100 cc. extract in 30 mins. gave 0.031 per cent. HCN.

25 grs. cake + 15 grs. ground plant in 30 mins. gave 0.028 per cent. HCN.

25 grs. cake alone gave 0.031 per cent. HCN.

Sainfoin (variety giant), *Onobrychis sativa Lam.*—Cut when in full bloom. The extract, prepared as before, was difficult to obtain free from mould, even in presence of excess of toluene.

Temp. = 37.0°C.

25 grs. cake + 100 cc. extract in 30 mins. gave 0.029 per cent. HCN.

25 grs. cake + 15 grs. ground plant in 30 mins. gave 0.025 per cent. HCN.

25 grs. cake alone in 30 mins. gave 0.031 per cent. HCN.

Kidney Vetch, Anthyllis vulneraria L. Cut at a height of 10 inches. Although one of the fodders capable of hydrolysing amygdalin and other glucosides, the results obtained in this case were similar to the foregoing. The extract was prepared as above.

Temp. = 37.5°C.
Time of action = 30 mins.

25 grs. cake + 75 cc. extract gave 0.028 per cent. HCN.
25 grs. cake + 15 grs. ground plant gave 0.024 per cent. HCN.
25 grs. cake alone gave 0.030 per cent. HCN.

Helianti. A variety of *Helianthus macrophyllus.*—Cut at a height of 2 ft. Extracted as before.

Temp. = 38°C.
Time of action = 30 mins.

25 grs. cake + 100 cc. extract gave 0.018 per cent. HCN.
25 grs. cake + 15 grs. ground plant gave 0.013 per cent. HCN.
25 grs. cake + 20 grs. ground plant gave 0.011 per cent. HCN.
25 grs. cake alone gave 0.026 per cent. HCN.

Maize—Zea mais.—Young maize might have been expected to give a positive action on phaseolunatin, and increase the rate of generation of hydrocyanic acid from linseed, since it is known to contain at least one enzyme, which is of the

maltase type. No such action was obtained, however. The ground material was extracted as before.

Height of maize, 4 inches. Temp., 38°C. Time of action 30 minutes.

25 grs. cake + 100 cc. extract gave	0.021	per cent. HCN.
25 grs. cake + 20 grs. ground maize	0.019	per cent. HCN.
25 grs. cake alone	0.026	per cent. HCN.

Maize cut at a later period at a height of thirty inches gave, under the same experimental conditions, the following results :—

25 grs. cake + 100 cc. extract gave	0.021	per cent. HCN.
25 grs. cake + 15 grs. ground plant gave	0.017	per cent. HCN.

The results obtained with the different green fodders are of a highly interesting character. In the first place, the action of the various plant extracts, either in a positive or negative direction is very small and is not, apparently, definitely to be correlated either with the existence in them of active enzymes or of inhibiting substances like sugars, etc. On the other hand, where the finely ground plant is used, an invariable and considerable inhibition of the prussic acid formation takes place. This was repeatedly confirmed both under the same and altered conditions of experiment to admit of thorough mixing by shaking, etc.

Which of the insoluble components of the fodders caused this action was investigated in the case of Helianti, a very coarse fodder, which had given very marked inhibition, ground plant to the extent of 80 per cent. by weight of the cake used decreasing the liberation of HCN during thirty minutes by over 50 per cent. 15 grs. of the finely ground fodder were extracted with ether in a Soxhlet apparatus for eighteen hours. The extract was freed from the solvent, mixed with a small quantity of water and completely transferred to a digestion flask with linseed cake as before. The residue in the Soxhlet was then similarly extracted with 90 per cent. alcohol for twenty-four hours, and the effect of the alcoholic extract on linseed cyanogenesis determined. Finally the residual material was extracted with boiling water, and the effect of the filtered liquor found. The action of the residual extracted material was also determined. The results obtained were as follows :—

Temp. 35° C. Weight of cake used in each case, 25 grs. Time of action=30 minutes.

Material used.	HCN. liberated per cent.
Cake alone	0·021
Cake + ether extract ..	0·019
Cake + alcoholic extract ..	0·017
Cake + aqueous extract ..	0·019
Cake + extracted residue ..	0·010

Although there is thus some difficulty in correlating the separate results with the total effect of the fodder previously described, there is no doubt that the greatest inhibiting effect is due to the bulky cellular residue, the main constituent of which is without doubt crude fibre. Experiments were therefore directed to determine the effect of cellulose on the decomposition of the linseed cake glucoside.

Effect of Cellulose on Cyanogenesis.

Cellulose was prepared in a fine, disintegrated condition by digesting Swedish filter paper, cut up into small pieces, successively with 2 per cent. sulphuric acid and 2 per cent. caustic soda. The residue was then washed until absolutely neutral.

The addition, in this form, of cellulose to linseed cake, depressed the formation of prussic acid in a similar manner to the fodders. The effect of cellulose was consequently more closely examined by working on the hydrolysis of the glucoside amygdalin by emulsin. The inhibiting effect was noticed in this case as with the linseed cake. A bulkier cellulose prepared from cotton wool was also used in the experiments, and a control carried out with the addition of starch was found to give practically the same result as the glucoside alone.

The amygdalin was used in 2 per cent. solution. The emulsin solution was prepared by digesting 1 gr. of Merck's emulsin with 100 cc. of chloroform water for several hours at 38° C., and then filtering off the insoluble material. The

estimations were carried out in the special apparatus previously described by the author (*loc. cit.*) and during the experiments with cellulose the flasks were shaken at frequent intervals.

TABLE VII.

INHIBITING EFFECT OF CELLULOSE ON THE HYDROLYSIS OF AMYGDALIN BY EMULSIN.

Temp., 38° C.

In each series the solutions were diluted to three times their volume with distilled water in order that the space occupied by the cellulose should be small compared with the total volume.

Series	Source of Cellulose.	Volume of Amygdalin. cc.	Volume of Emulsin. cc.	Weight of Cellulose added. grams	Time of Action.	HCN. formed. gram.	Decomposition of Amygdalin. per cent.
1	Filter paper (pulp)	10	10	—	30	0·00930	91·5
		10	10	1·0	30	0·00710	69·9
	. ——	10	10	1 gr. of starch as paste	30	0·00920	90·8
2	Filter paper (coarser shreds)	20	10	—	15	0·00875	43·1
		20	10	0·6	15	0·00850	41·5
		20	10	1·1	15	0·00818	40·0
		20	10	1·3	15	0·00810	39·9
3	Cotton Wool	10	5	—	30	0·00937	92·3
		10	5	0·0	30	0·00737	72·6
		10	5	0·75	30	0·00512	50·4
		10	5	1·0	30	0·00495	48·7
		10	5	1·25	30	0·00487	47·9

The retarding effect of cellulose on the hydrolysis is thus very marked, but does not give results absolutely proportional to the amount added to the reaction mixture. The source, or probably rather the bulk, of the cellulose has a very considerable effect on the inhibition, the voluminous cotton wool causing much more retardation than the more compact filter paper, weight for weight, although more complete pulping of the latter material makes its action more noticeable. The inference drawn was that an adsorption compound with the colloidal cellulose had been formed, either by one of the reacting bodies or by the products of hydrolysis. Remembering that many of the sugars form compounds with HCN and effect considerable retardation of the hydrolysis of cyanogenetic glucosides, suspicion was first cast on the prussic acid, but this possibility, at any rate as an explanation of the main effect, was set aside after an examination of the above results and carrying out a series of experiments on the hydrolysis of salicin by emulsin. Cellulose was found to inhibit the latter reaction, and the course of hydrolysis in each may be gathered from the results given below in Table VIII. 100 c.c. of a 2 per cent. solution of salicin were mixed with 10 c.c. of the emulsin solution and 1 gr. of cellulose prepared from cotton wool. 10 c.c. of the reaction mixture were removed every ten minutes, mixed with 1 c.c. of 10 per cent. caustic soda, and the sugar estimated by reduction of Fehling's solution. A similar set of experiments was carried out without the addition of cellulose. (See Table VIII, p. 310.)

Formation of an Adsorption Compound between Cellulose and Enzyme.

The results rendered it more probable that the inhibition was due to the removal of part of the enzyme by the formation of an adsorption compound with the cellulose. In order to test this possibility, advantage was taken of the characteristic feature of adsorption compounds that the amount of colloid taken up is not doubled when the concentration is doubled but increases at the rate of 2 to the power $\frac{1}{n}$, where n lies between 1 and 2. In this particular case, if an adsorption compound is formed between the two colloids—enzyme and cellulose—relatively more of the compound should

Table VIII.

Inhibition of the Hydrolysis of Salicin by means of Cellulose.

Temp. 38° C.

Time of Action. mins.	Control without Cellulose.		With Cellulose.	
	Cu reduced. gram.	Salicin decomposed. per cent.	Cu reduced. gram.	Salicin decomposed. per cent.
0	—	—	—	—
20	0·0730	35·9	0·0500	27·5
30	0·1100	54·2	0·0740	36·4
45	0·1375	67·7	0·1211	59·5
150	0·1940	95·5	0·1815	88·7

be formed in dilute solutions. Put in other words, with increasing quantities of emulsin, the amount of compound formed, *i.e.*, the relative amount of inhibition, will not be proportional to the amount of enzyme, but as stated above, will be less than two for a doubled quantity.

The experiments were carried out with amygdalin and emulsin, and to obtain comparative results it was necessary to choose only dilutions of enzyme where, in the ordinary way, the amount of decomposition would be a linear function of the quantity of enzyme used. (See Table IX, p. 311).

Taking the formula $\frac{V_1}{V_2} = \left(\frac{C_1}{C_2}\right)^y$ where V_1 and V_2 are the velocities corresponding with the concentrations C_1 and C_2, the values of y for the control experiments approximate to one throughout. Examination of the series of experiments with the addition of cellulose shows at once that the decomposition is no longer proportional to the amount of enzyme present, but increases appreciably throughout, the amount of inhibition decreasing from about 40 per cent. to only 14 per cent. This can be seen graphically in the

Table IX.

Effect of Cellulose on the Hydrolysis of Amygdalin by Increasing Amounts of Emulsin.

In the following experiments 25 cc. of amygdalin solution (2 per cent.) were mixed with a 2 per cent. solution of emulsin, with and without the addition of 0.75 gr. of cellulose.

Temp. 38.3°C. Time of action, 10 minutes.

Experiment.	Volume of Emulsin Solution cc.	Control without Cellulose.		With Cellulose.		Amount of Inhibition. per cent.
		HCN. formed. gram.	Amygdalin decomposed. per cent.	HCN. formed gram.	Amygdalin decomposed. per cent.	
a	1	0·00129	5·01	0·00090	3·52	1·49
b	2	0·00258	10·11	0·00200	7·84	2·27
c	3	0·00380	14·90	0·00310	12·14	2·76
d	4	0·00490	19·21	0·00400	15·70	3·51
e	6	0·00752	29·45	0·00640	25·10	4·35
f	8	0·00980	38·41	0·00820	33·14	5·27

accompanying curve (Fig. 2, p. 312). Taking the amount of inhibition as a measure of the assumed cellulose-enzyme compound formed, we get :—

		$2^{1/n}$	n
$^b/_a$	=	1.52	1.47
$^d/_b$	=	1.54	1.44
$^e/_c$	=	1.58	1.41
$^f/_d$	=	1.49	1.49

The usual values obtained for adsorption compounds vary from 1.4 to 1.7. Considering the difficulty of obtaining constant experimental conditions, the results are remarkably uniform and congruent, and may be taken in conjunction with those previously quoted, as proof of the formation of an adsorption compound between the enzyme and cellulose. Without doubt this is the cause of the inhibiting action of the latter compound in linseed cyanogenesis.

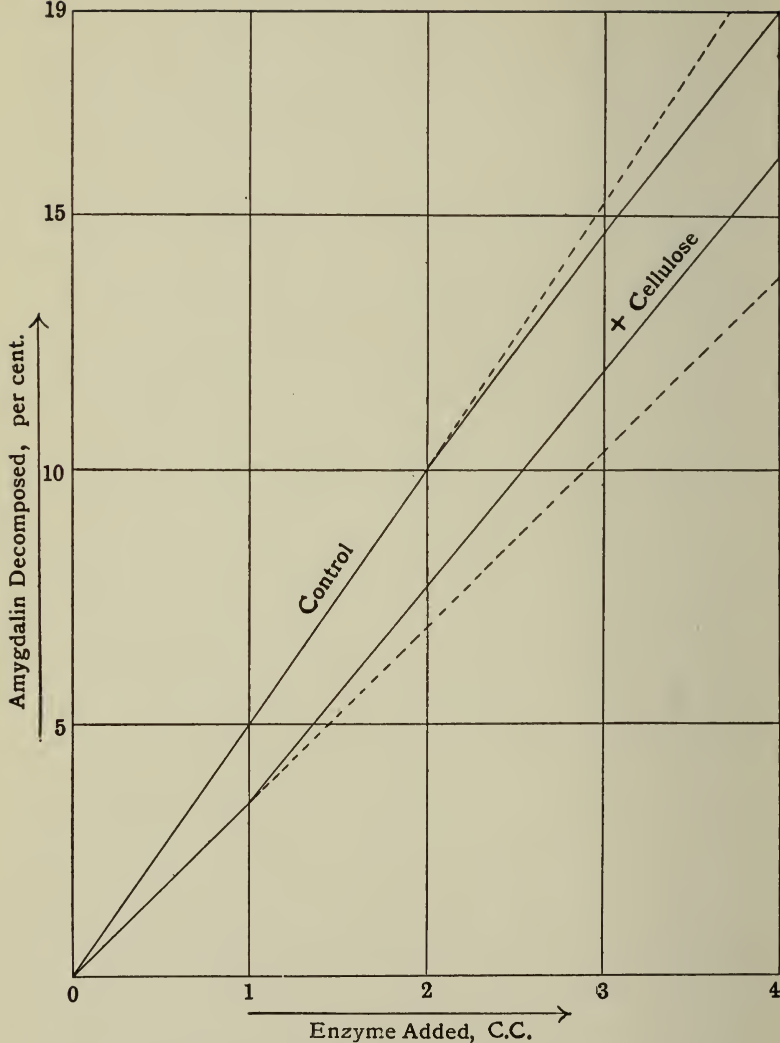


Fig 2. Effect of Cellulose on the Hydrolysis of Amygdalin by Emulsin.

Highly interesting in this connection is the view adopted by Klug[10] that the mucin of the intestinal mucous membrane protects the organs from attack by the digestive juices by the formation of adsorption compounds with the enzymes.

If the digestive enzymes are absorbed in a similar manner by the colloids, and particularly cellulose, present in the foods in the alimentary canal, an excess of fibre, whether digestible or not, will impose a severe drain on the animals secretive powers and may well be partially responsible for the low "value" attributed to many such feeding stuffs. The author proposes carrying out experiments to test the accuracy of this view.

Effect of other Substances on the Formation of Prussic Acid from Linseed.

Salt.

Although in general the neutral salts have no great effect on the hydrolysis of glucosides by enzymes and the author in conjunction with Henry[4] (*loc. cit.*) has shown sulphate of ammonia to be practically without action, common salt, which is, of course, likely to be fed at the same time as linseed, has a distinct inhibiting action on the liberation of prussic acid from linseed cake. The quantity of salt added is proportionately to the weight of cake about that likely to be given in practice.

Table X.

25 grs. linseed cake used for each experiment.

Time of Action. min.	Temperature. °C.	NaCl. added. grams.	HCN. formed. gram.	HCN. formed. per cent.
30	35	—	0·00532	0·0213
30	35	1.5	0·00467	0·0187
30	36	—	0·00550	0·0220
30	36	1·5	0·00470	0·0188

Sugars and Sugar-containing Feeds.

The inhibitory action of d-glucose on the hydrolysis of glucosides by enzymes has repeatedly been noticed by investi-

gators in this field. On the other hand the biose sugars in general have no such action. The possible activity of the sugars is of special importance in the present case, since they are very likely to be present in other food stuffs and in the form of molasses or molasses-feeds may possibly be given in the free condition. Experiments were therefore carried out with cane sugar, glucose and with ordinary feeding molasses.

Cane Sugar.

An extended series of experiments with this material were carried out, but with negative results. No appreciable inhibitory action was noticed with quantities of cane sugar up to 40 per cent. by weight of the linseed cake incubated with water at 36° C.

Glucose.

Commercial glucose in the form of a ten per cent. solution was added in increasing amounts to definite quantities of linseed cake made into a thin paste with water. The inhibiting action on the liberation of prussic acid was found to be very marked. This is in agreement with results previously obtained with isolated glucosides. The results obtained are quoted below.

TABLE XI.

INHIBITING ACTION OF GLUCOSE ON LINSEED CYANOGENESIS.

For each experiment 25 grs. of cake were incubated for 30 minutes under the usual conditions.

Temp., 38° C.

Weight of Cake. grams.	Weight of Glucose added. gram.	HCN. formed. gram.	HCN. formed. per. cent.
25	–	0·0055	0·0220
25	1	0·0037	0·0150
25	2	0·0032	0·0130
25	4	0·0029	0·0115
25	5	0·0025	0·0102

Molasses.

Molasses consists largely of cane sugar. There is always, however, a quantity of hexose sugar present (glucose may amount to 20 to 30 per cent.) besides a high proportion of non-protein nitrogenous material, which averages about 10 per cent., and large amounts of inorganic salts. Added in quantities, expressed as actual sugar, up to 10 per cent. by weight of the linseed cake used, the inhibiting action was very strong; so strong, in fact as to leave little doubt that the glucose present is not the only agent active in preventing the formation of hydrocyanic acid, and the possibility of the "amides" and the inorganic salts having an action must be considered.

In the following experiments the molasses used contained 60 per cent. of total sugars; 100 grs. were diluted to 300 cc. with water, so that 1 gr. of sugar was contained in 5 cc. of solution.

TABLE XII.

INHIBITING ACTION OF MOLASSES ON LINSEED CYANOGENESIS.

25 grs. of cake were used for each experiment. Time of action, 30 minutes. Temp., 36° C.

Sugar added as Molasses. grams.	HCN. formed. gram.	HCN. formed per cent.
0	0·0055	0·0220
1	0·00412	0·0165
4	0·00370	0·0148
5	0·00365	0·0146
6	0·00360	0·0144
9	0·00325	0·0130
10	0·00320	0·0128

The considerable inhibition of the formation of prussic acid effected by molasses may be regarded as of special im-

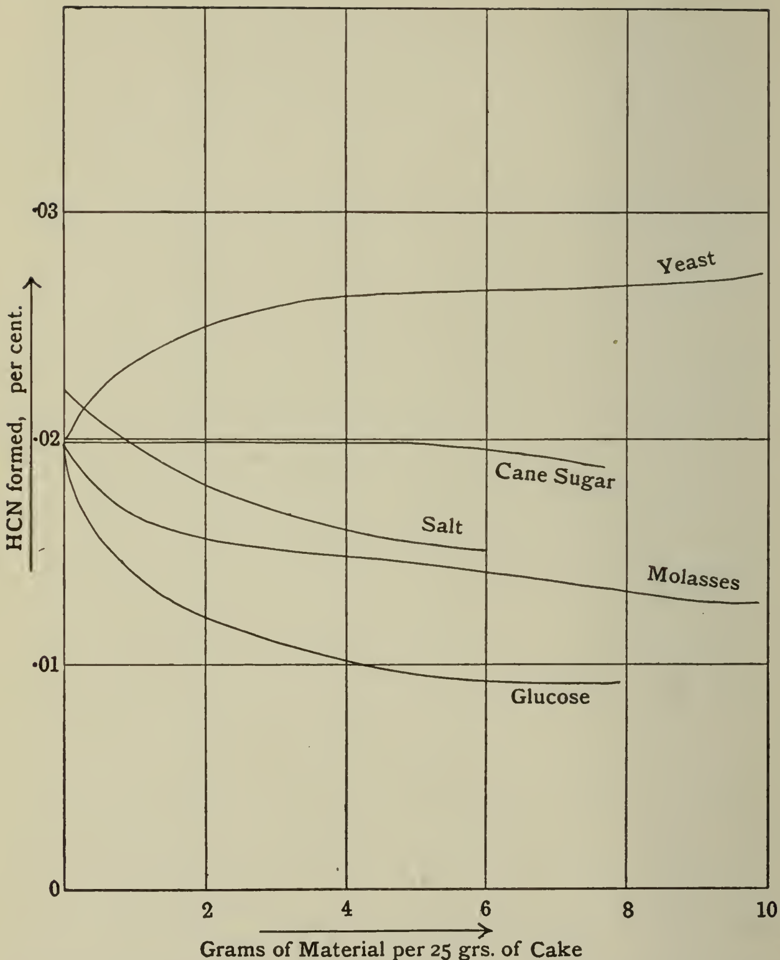


Fig. 3. Effect of various materials on the Formation of Hydrocyanic Acid from Linseed Cake.

portance since it may be used either in the liquid form or as a molasses feed, in conjunction with linseed cake or other of the more markedly toxic prussic acid containing feeding stuffs such as Java beans or sorghum. Indeed a definite recommendation to feed glucose or molasses may be made, particularly in the latter cases.

The effects of the "secondary" feeding stuffs, etc., *e.g.*, the sugars, molasses, salt and yeast are graphically represented in the accompanying curve (Fig. 3, p. 316).

Conditions in the Digestive Tract Relative to the Formation of Prussic Acid from Linseed.

Factors likely to influence the formation of hydrocyanic acid from feeding stuffs in the digestive organs of the animal are the acidity and alkalinity of the media and the various digestive enzymes. The action might conceivably be either positive or negative, since small quantities of acid and alkali are known to increase the activity of certain enzymes, and there is always the important possibility of the secretion in the alimentary canal of a ferment capable of effecting the hydrolysis of cyanogenetic glucosides. On the other hand higher concentrations of acid and alkali might inactivate or destroy the specific feeding-stuff enzyme and the action of the commoner digestive enzymes—pepsin and trypsin—might also be expected to lie in the direction of inhibition or destruction of its activity.

Effect of Acids and Alkalis.

The influence of dilute acids and alkalis on the hydrolysis of isolated phaseolunatin and amygdalin is so considerable (Auld *loc. cit.*) that a statement by Lander (*loc. cit.*) to the effect that "fermentation goes on in 1 per cent. hydrochloric acid and also in 1 per cent. sodium bicarbonate solutions, and would not therefore be inhibited by the body fluids" appeared surprising.

On repeating the experiments it was found that this is a purely empirical assertion, and though the action does continue to a certain extent, the inhibition is nevertheless very marked and might well make all the difference between toxicity and non-toxicity. Thus with incubation carried

out in a 1 per cent. solution of hydrochloric acid the following results were obtained :—

Weight of cake, 25 grs. Temp., 36° C.

Time of Action. mins.	HCN. formed.	
	In 1 per. cent. HCl. Solution. per cent.	In Water. per cent.
15	0·0025	0·015
30	0·0035	0·022
60	0·0059	—

Very similar results were obtained with sodium bicarbonate solution. On the other hand more dilute solutions (0.1, 0.2 per cent., etc.) had much less effect and are more likely to represent the actual conditions in the digestive organs. The increased stability of the enzyme towards acid when existent in the cake is noteworthy. Emulsin, for example, when isolated, is completely inactivated by 0.1 per cent. hydrochloric acid.

Effect of Digestive Juices.

Previous to actual feeding experiments with animals, attention was turned to the effect of isolated pepsin and extract of the digestive stomach of a sheep on the cyanogenesis of linseed cake.

A 1 per cent. solution of pepsin was prepared by dissolving 10 grs. of Witte's pepsin with 96 cc. of $N/2$ HCl. in 1 litre of water. The concentration of the acid was thus brought to 0.2 per cent. ; 100 c.c. of this solution were mixed with an equal bulk of water and added to the linseed cake as before. A control series of experiments was carried out with water. (See Table XIV., p. 319.)

The action, though smaller than some of the inhibitions recorded above, is distinct, and there is no doubt that the linseed enzyme is partially digested and its activity destroyed at the same time as the other proteins. In the circumstances, and in order to reproduce more nearly the conditions existing

Table XIV.

Action of Pepsin-Hydrochloric Acid on the Formation of Prussic Acid.

For each experiment 12.5 grs. of cake were used.
Temp., 38.5° C.

Time of Action.	With Pepsin.		Control without Pepsin.	
	HCN. formed. gram.	HCN. formed. per cent.	HCN. formed. gram.	HCN. formed. per cent.
15 min.	—	—	0·0021	0·017
30 ,,	0·0026	0·021	0·0033	0·026
60 ,,	0·0037	0·030	0·0048	0·038
2 hrs.	0·0049	0·039	0·0057	0·046
9 ,,	0·0059	0·047	0·0065	0·052

in the stomach, an experiment was carried out by mixing equal weights of linseed cake and dried and ground lucerne, and incubating the mixture with the pepsin solution. In forty-five minutes 0.016 per cent. of HCN was generated as against 0.023 per cent. in a control experiment without lucerne.

An extract of the fresh digestive stomach of a sheep was prepared by mincing the lightly washed organ and extracting with a 3 per cent. solution of glycerine containing 0.2 per cent. of hydrochloric acid. The mixture was vigorously stirred for six hours at 38° C. and filtered. Although the extract was active towards coagulated white of egg, the results obtained on mixing with ground linseed cake were uncertain and equivocal. Nevertheless they acted as a control to the experiments quoted in Table XIV. and proved that the effects noted there are due chiefly to the pepsin, and only partially to the dilute hydrochloric acid.

Feeding Experiments with Animals.

(In Collaboration with Professor T. W. Cave, F.R.C.V.S.)

Through the kindness of Professor Cave, by whom the experiments were carried out, feeding trials with guinea pigs

and sheep were instituted in order to determine (*a*) whether the cyanogenetic glucosides themselves are toxic or capable of producing hydrocyanic acid by the action of enzymes present in the digestive organs, and (*b*) whether linseed cake of high "free" prussic acid content can induce poisoning under known conditions.

Experiments with Cyanogenetic Glucosides.

For these experiments amygdalin and phaseolunatin were used, and fed to guinea pigs. Taking as an average a guinea-pig of $1\frac{1}{2}$-lbs. weight, then weight for weight a lethal dose of prussic acid should be $\frac{1}{93}$ of the human lethal dose, generally taken at one grain.

Owing to the difficulty of inducing the animals to take solutions of the glucosides, weighed quantities of the latter were absorbed into separate lots of 3 grams of bran which were dried and fed to the animals.

Starting with quantities of amygdalin and phaseolunatin corresponding to two lethal doses of HCN the amounts were gradually increased, with intervals of two or three days "rest" between increments, up to twelve lethal doses without any effect whatsoever. The heaviest doses amounted to 0.33 gram amygdalin and 0.15 gram phaseolunatin respectively. Calculated for a sheep (126-lbs.) on the same basis this would be 26.4 grams amygdalin and 12 grams phaseolunatin; in the latter case as much glucoside as would be present in $7\frac{1}{2}$-lbs. of a 0.4 per cent. HCN linseed cake.

It may be taken therefore that the cyanogenetic glucosides are not hydrolysed by the animals' digestive juices, and there is no fear of HCN being formed from a feeding stuff containing glucosides of this type if the enzyme is absent or previously destroyed.

Feeding Trials with Linseed Cake.

The experiments were carried out with two sheep—tegs, A (Kent, weight, 84-lbs.) and B (Southdown, weight, 50-lbs). Both were normal and in good condition. The cake used was that containing 0.052 per cent. HCN (S), previously described.

Sheep A.—Kept without other food and received on successive days 1-lb. crushed cake, 1-lb. crushed cake, 2-lb. crushed cake, 3-lb. crushed cake moistened with water, 4-lb. crushed cake moistened with water. No results were noticed. The animal ate the cake readily, but in quantities over 4-lb. would not eat the whole ration.

Sheep B.—Kept without other food and fed as follows :

(1) Kept without food for twenty-four hours and then given 1-lb. ground cake soaked with warm water for eighteen hours. This ration smelt very strongly of prussic acid. Animal started to eat and then refused. Eventually ate about one-third during nine hours. No definite result, but sheep was thought to look rather sickly. Remainder of cake removed.

(2) After a further lapse of one day fed 1-lb. soaked cake as in (1). Animal very hungry, but again refused the food.

(3) Kept for thirty-six hours without food, and then gave 1-lb. ground cake soaked with water half an hour before use. The smell of HCN in this case was hardly so pronounced as in (1). Ration eaten fairly readily. After three hours gave another 1-lb. of cake which had soaked for six hours. This was also partly eaten, but not so readily as the first pound. No definite result was obtained, but the sheep was distinctly sick in appearance.

Lethal Dose of Prussic Acid as Potassium Cyanide.

Sheep B.—Given, per mouth, 1.2 grams potassium cyanide. This is equivalent to 7.8 grains of prussic acid, the amount available from 2-lb. of the linseed cake S. The poison took effect in 30 seconds, and the sheep died within 3 minutes.

Sheep A.—Given, per mouth, 0.6 gram potassium cyanide, equivalent to 3.9 grains of prussic acid, the amount available from 1-lb. of linseed cake S. Toxic symptoms were noticed after 90 seconds, and the sheep eventually died in 12½ minutes. In the latter experiment there is no doubt that the minimum lethal dose for the sheep was nearly reached.

In this case the animal was given the cyanide after a full meal, whereas Sheep B had very little in its stomach.

It is noteworthy that Sheep B would not eat well soaked

cake, which smelt strongly of HCN even when kept without food for some time, whereas cake soaked in cold water shortly before use and giving less obvious evidence of prussic acid content was taken more readily and without fatal effect, although the animal showed symptoms of slight poisoning.

The conclusions drawn from the feeding experiments were that the prussic acid from linseed cake fed in the dry state is not rapidly generated in the animal's stomach, whereas soaked cake if eaten *at once* may well prove dangerous.

The lethal dose of prussic acid seems to be higher in ruminants than in man, yet, Lander's figures (*loc. cit.*) obtained with a heifer seem rather too high and argue a certain amount of accustomisation.

The main point made by the experiments is, however the fact that the lethal dose for sheep can readily be reached with a linseed cake of fairly high prussic acid content, and weight for weight, one may argue the same to hold good for calves.

Para Rubber Seed Cake.

The seeds of the para rubber tree contain a valuable oil and have been shown to contain a quantity of cyanogenetic glucoside and to liberate prussic acid on soaking with water.[18] From analogy with linseed it might therefore be expected that the oil cake obtained after expression of the oil would contain a considerable quantity of prussic acid.

A consignment of para rubber seed cake, with which feeding trials were carried out, was found, on examination, however, to contain no hydrocyanic acid, either in the "free" or in the combined condition.

The author wishes to express his best thanks to Mr. Duncan Mosscrop, B.Sc., for his help during the course of this investigation.

Summary of Results, and Conclusions.

The results obtained during the investigation may be summed up as follows :—

1. The majority of linseed cakes examined produced

prussic acid on maceration with water, the amount varying from 0.001 per cent. to 0.052 per cent. In only a few cases was no HCN formed, owing to the enzyme having been destroyed. The "total" prussic acid content of the cakes examined varied from 0.203 per cent. to 0.056; average 0.036 per cent.

2. The rate of generation of hydrocyanic acid varies with different cakes, and is largely dependent on the temperature of incubation. The formation at blood-heat is extremely rapid, half of the available prussic acid being sometimes produced in fifteen minutes, and the maximum practically attained within six hours.

3. The enzyme is easily destroyed by mixing the ground cake with boiling water, and a linseed cake gruel properly prepared with boiling water develops practically no prussic acid, even after six hours.

4. Yeast and yeast containing feeds decompose the linseed glucoside and hasten the generation of prussic acid.

5. All the green fodders examined, when in a finely-divided condition, strongly inhibit the formation of prussic acid even when they contain glucosidoclastic enzymes. The action is chiefly due to their crude fibre or cellulose.

6. Cellulose also inhibits the hydrolysis of amygdalin and salicin by emulsin. The action is caused by the formation of an adsorption compound between the two colloids, enzyme and cellulose.

7. Salt, glucose and molasses strongly inhibit the generation of prussic acid. Cane sugar is practically without effect.

8. Of the conditions prevailing in the digestive tract, acidity and alkalinity both have inhibiting influence. The digestive enzymes also slightly retard the action by attacking the feeding stuff enzyme.

9. The cyanogenetic glucosides phaseolunatin and amygdalin are non-toxic and are not hydrolysed with the formation of prussic acid in the animal body.

10. No fatal poisoning was observed by feeding sheep with linseed cake containing 0.052 per cent. of free prussic acid. When well soaked the material is refused by sheep even when hungry, and the moderate quantities taken after keeping the animals without food induce slight poisoning

11. Death was induced in two sheep weighing 50-lbs. and 80-lbs. by 7.8 and 3.9 grains of HCN respectively. These quantities are equivalent in the former case to 2-lbs. and in the latter to 1-lb. of the linseed cake S. (0.052 per cent. HCN.).

From a due consideration of the results obtained one is forced to the conclusion that when properly administered, linseed cake will have little poisonous action. The actual amounts fed at a time are small. Because of its price and other considerations linseed cake is generally only used as a finishing material, and used as one of a mixture of several concentrated feeding stuffs. As a rule this, in itself, is sufficient to bring the maximum amount of prussic acid which could be produced below the lethal dose for the animal fed. The practice also of giving at the same time bulky amounts of green fodder or hay most energetically inhibits the generation of the poison. Indeed practically every circumstance is against the prussic acid. Salt, sugar and other adjuncts to feeding all exert considerable influence in preventing its formation, and the animals' digestive juices instead of themselves causing the liberation of HCN, as was feared, actually take an active part in its prevention.

The varied inhibition effects, and particularly that of the fodder-cellulose, may largely account for the fact stated by Hendrick[17] that in the case of Java beans many tons of material were consumed without ill effect. Indeed material which had caused fatal poisoning in one place was fed to a dairy herd on another farm for several weeks without any evil results being noticed.

On the other hand, with the use as a feeding stuff of material capable of producing four grains of prussic acid per pound it is obvious that a certain amount of care must be exercised. Thus fermented, mouldy or yeast-containing foods should be avoided for use with linseed or linseed cake. The gravest chance of misadventure occurring, however, is in the preparation of linseed gruel, where the cake is fed wet. Gruel which has not been made with boiling water and which has been allowed to stand some time before feeding may well prove extremely dangerous, and, particularly if given to calves which are not in good condition, is probably the cause of the

few authenticated poisoning cases which have occurred. Against this must be set the rather larger amount of prussic acid or its equivalent in potassium cyanide, which is necessary to cause death in herbivorous animals, but different animals will vary in susceptibility to the poison, and there is no evidence to show that a certain amount of accustomization to prussic acid cannot be attained.

The fact that phaseolunatin itself is non-poisonous to ruminants and that a linseed gruel in which the enzyme has been killed by heat is quite innocuous is difficult to reconcile with the assertion of Guignard[14] that Java beans, which contain the same glucoside, are poisonous even after boiling "since this process merely destroys the enzyme and not the cyanogenetic glucoside."

The accumulated evidence of the feeding experiments carried out in this investigation and by Lander seems to show that in normal cases the maximum amount of hydrocyanic acid actually formed from linseed cake is below that likely to cause death. Nevertheless the total amount of free or available HCN (whether actually formed in the animal's stomach or not) may easily reach the lethal dose. It seems essentially desirable therefore that the amount of free prussic acid in a cake should always be measured, and, except that it might, in some cases, lead to distrust of a useful and harmless material, the quantity present should be stated along with the guarantee on the invoice. Cakes with more than 0.03 or 0.04 per cent. of free HCN should be used with caution and any, like those examined by the author, which contain 0.05 per cent. or more of free prussic acid, should particularly be regarded with suspicion and carefully fed, despite the negative results obtained by feeding them to sheep.

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THE EXTRACTION OF NICOTINE FROM TOBACCO.

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Nicotine, the active principle of tobacco, is a complex alkaloid occurring in all parts of the plant, but in largest quantity in the leaves. It is found to be present in the earliest stages of the growth and development of the tobacco plant, and attains its maximum value in the leaves at maturity, appearing to be produced by complex changes from certain albuminoid constituents, by a process analogous to ripening in fruits.

It has long been known that a dilute solution of nicotine in water forms a most efficient spray for the destruction of certain insect pests infesting plants, notably the different varieties of aphis, and the apple sucker, while nicotine has no equal as regards its power of destroying the sheep-scab mite, and certain other animal parasites. In spite of the great value of this substance as an insecticide, however, its extensive use by farmers and horticulturists is largely hindered by the comparatively high price (15s. per lb.) of the pure alkaloid.

This high price, prohibitive in many cases, is due to the fact that the extraction of the nicotine from the tobacco plant, or more often from waste tobacco products, and its subsequent purification, are lengthy, complicated, and hence expensive processes. Again, the necessary technical details of the preparation are trade secrets, in the hands of only a few manufacturers, who hence hold a monopoly and are thereby able to keep up the price of pure nicotine.

The actual extraction of the alkaloid from the leaves is carried out by treating the latter with water, and is not usually attended with much difficulty. The separation of the nicotine from the aqueous extract in order to prepare the pure substance and hence save the carriage on the large volume

of water, is, on the other hand, a series of decidedly complicated manipulations, including extraction with ether, distillation in an atmosphere of hydrogen, and other processes requiring the use of very special appliances and apparatus.

Before nicotine can be employed as a spray, it has to be largely diluted with water, so as to give a solution containing generally not less than .075 per cent. of nicotine. Obviously therefore the cost of a nicotine solution for spraying could be materially lessened if the aqueous extract were prepared on the spot directly from the leaves themselves, as thereby would be obviated the expensive removal of the water from this extract in the preparation of pure nicotine, an expense entirely borne by the ultimate consumer. If also the tobacco plant itself were grown on the spot, an additional saving on the cost of carriage of the leaves would be effected.

A number of experiments have been carried out at this College in order to determine practically whether it is possible to produce in this country, by systematic breeding, a tobacco with a high percentage of nicotine.

These experiments are now completed, and the results obtained are published in the *Journal of the South-Eastern Agricultural College*, Nos. 19 and 20.

The problems with which this present paper proposes to deal have not, however, to do with the actual growth of the tobacco, but with the extraction of the nicotine from the leaves, and with the production in one operation of a liquid suitable for spraying purposes.

The Forms in which Nicotine exists in the Tobacco Plant.

Chemically speaking, nicotine under certain conditions acts as a mon-acid base and is hence capable of combining with acids, to form salts. The acids existing naturally in the leaves of the tobacco plant are largely malic and citric acids, sometimes up to 10 per cent. of the total weight of the dry leaf consisting of a mixture of these acids in different proportions. These acids combine with the potash and the lime present to give the corresponding potassium and calcium salts, while the amount of the acids left over, and there is always an excess of these present, combines with the nicotine to form salts, nicotine

malate and nicotine citrate. The excess of nicotine, if any, exists in the free state, uncombined with any acid.

It is thus seen that the total nicotine in tobacco exists in two states, firstly as salts of citric and malic acids, secondly as free uncombined nicotine, and indeed the "strength" of a tobacco for smoking purposes seems to depend upon the amount of free nicotine, and not the total nicotine, in fact a "mild" smoking tobacco may actually contain more nicotine than a "strong" tobacco, provided that the nicotine in the former case is largely combined with acids.

Some solvents possess the power of extracting the total nicotine from a sample of leaf, while others can only remove the free nicotine, and in this way values for the amounts of free and combined nicotine can be arrived at. It is shown later that water belongs to the first of the above classes of solvents, and is thus capable of completely extracting the total nicotine.

Quantitative Estimation of Nicotine.

The leaves were cut into pieces of suitable size, without removal of the mid-rib, and then dried at a temperature of 60° C. in an air oven for twenty-four hours. While still warm the leaves were finely ground in a hand-mill, and the resultant powder thoroughly exposed to the air for five or six hours, in order to allow of the absorption of atmospheric moisture, and to give what was called the "air-dried" sample. It was found that if this exposure to the air were not carried out, the powder absorbed atmospheric moisture fairly readily, with the result that it was almost impossible to weigh out accurately a sample of the powdered leaf.

The method then employed for the quantitative estimation of the nicotine in the "air-dried" sample was that devised by Kissling, as follows :—

Ten grams of the air-dried sample were placed in a small beaker, and ten cc. of Alcoholic Soda solution added.* The object of this treatment with Caustic Soda is to convert

* The alcoholic soda solution employed was prepared by dissolving 6 grams caustic soda in 40 cc. distilled water and 60 cc. 90 per cent. alcohol. 10 cc. of this solution contains caustic soda more than sufficient in amount to liberate all the combined nicotine present in 10 grams leaves containing up to 10 per cent. total nicotine, an amount which is practically never attained.

all the nicotine into the "free" state, in order to facilitate its removal by the ether.

The mixture was well stirred, and when homogeneous, was plated in a filter paper cartridge, and extracted in a Soxhlet extractor for five hours with ether. The ether was then distilled from the extract on the water bath, and the residue, containing all the nicotine, taken up with 50 cc. of a ·4 per cent. aqueous Caustic Soda solution. The green liquid was transferred to a 500 cc. flask, and distilled in steam, with very efficient condensation. The distillation was carried on till about 400 cc. had collected in the receiver, and then another 200 cc. was collected in a second receiver, the reason for collecting this second portion being to ensure that all the nicotine had distilled over. If any nicotine were found to be present in the second portion collected, the distillation was then continued for a short time. This was found to be seldom if ever necessary.

The distillates were titrated with $\frac{N}{2}H_2So_4$ solution, using cochineal as indicator, and from the amount of the standard acid used the percentage of the nicotine was readily calculated. This method of estimation, although somewhat lengthy, was the one finally decided upon after an examination of other methods, and all the nicotine percentages given in this paper were arrived at by the method described.

Extractions of Tobacco Leaves with Distilled Water.

Distilled water is a liquid which, with regard to nicotine extraction, was found to remove not only the free nicotine, but also the alkaloid combined in the form of salts.

The first series of experiments carried out was to determine the effect of distilled water upon the finely-powdered, air-dried leaf, as regards nicotine extraction.

These extractions were performed in two series in order to determine :

(*A*.) the effect of *temperature* of the water upon the extraction ;

(*B*.) whether the amount of nicotine extracted by water at any fixed temperature depends upon the actual *percentage of nicotine in the leaf*.

A. The effect of the temperature of the water upon the extraction of nicotine.

A sample of air-dried tobacco leaves containing 4.6 per cent. nicotine was employed for this series of experiments. Ten grams of this powdered leaf were extracted with 400 cc. distilled water in two equal amounts, the mode of procedure being to thoroughly mix the powdered leaf with 200 cc. water at the temperature required, allow to stand for two minutes, filter the liquid extract from the leaf in a Buchner filter, and then treat the residue of extracted leaf with another 200 cc. water heated to the same temperature as before. The reason for treating the leaf a second time with water was rather to wash off any of the aqueous extract still adhering than in the hope of bringing about any further extraction of nicotine.

After extraction the amount of nicotine still remaining in the powdered leaf was estimated, it being found more convenient to determine the nicotine remaining in the leaf rather than that present in the solution, as the solution always contained, in varying amounts, ammonia and ammonium salts, which, being volatile in steam, rendered useless the ordinary method of estimating the nicotine by steam distillation, unless some absorbent material such as chalk were employed to soak up a known weight of the liquid, the nicotine then being extracted with ether in the usual way.

I.—*Extraction of air-dried tobacco leaves containing* 4.6 *per cent. nicotine with* 400 cc. *water, in two equal amounts of* 200 cc. *at different temperatures.*

Temperature of water.	*Percentage of Nicotine in leaf after extraction.*
13° C.	.1 (4)
30° C.	.1 (6)
50° C.	.1 (4)
70° C.	nil.

These results show that practically complete extraction is secured at every temperature, as it is highly probable that the small percentage of nicotine still remaining in the leaf after treatment is due, not to incomplete extraction, but

rather to the fact that the nicotine solution is not completely removed from the leaf.

The strength of the aqueous solution obtained in these experiments was 4.6—.1=4.5 grams nicotine per 4,000 cc. water, since starting with 100 grams leaf containing 4.6 grams nicotine, there were obtained 4,000 cc. solution, leaving .1 gramme nicotine unremoved from the leaf.

Strength of solution therefore was $\frac{4.5}{4,000} \times 100 = .11$ per cent. or about one-and-a-half times as concentrated as the .075 per cent. solution found by Pickering to be the weakest solution that can be effectively employed for spraying purposes.

The colour of the water extract was a rich reddish-brown, very much resembling strong tea. This colour is not due to the nicotine, but to the presence of colouring matter extracted from the leaf by the action of water.

That several substances other than nicotine are removed from tobacco leaf by the action of water is a well-known and not surprising fact; moreover, in this connection an important point has been noted by Pickering (see Mr. Garrad's Report in this series, "The Growing of Tobacco for Nicotine Extraction," Part I., p. 54), that one or more of these extracted substances is undoubtedly efficacious in the destruction of those pests against which nicotine itself is generally employed.

The above results show that water at the *ordinary* temperature can be employed in order to completely extract the nicotine from the leaf *if the latter is finely ground.* The fact that *cold* water can be successfully used is of great importance, as nicotine is a very readily volatile substance, especially in steam or water vapour, consequently the extraction of nicotine from tobacco by hot or boiling water undoubtedly leads to the loss of a greater or less percentage of the alkaloid through direct evaporation or volatilization with the steam given off from the water. In fact, on boiling a solution of nicotine, a very rapid loss of the alkaloid takes place, as shown in the experimental results given below.

If, however, the operation were carried out in a perfectly closed vessel, a matter of some little difficulty on the large scale, the loss of nicotine by this means would be entirely prevented.

The reason for the general employment of hot or boiling water for the extraction of nicotine from tobacco residues is that these residues are not finely ground, but are often in comparatively large pieces. As will be shown later on, this fact renders the extraction less efficient, and for this reason hot water is used instead of cold, as the hot water is able to secure a separation of a larger percentage of the nicotine from the leaf.

Unless carried out in closed vessels, however, or with water below about 60° C. this procedure is economically unsound and always results in the loss of a certain proportion of the nicotine present.

II. *Loss of nicotine from aqueous solutions of the alkaloid, by boiling in open vessels for different lengths of time.*

In order to demonstrate the fact that nicotine solutions become weaker on boiling in air, and to determine the actual loss of the alkaloid on boiling solutions of different strengths, the following series of experiments were carried out.

Pure nicotine was dissolved in water to give one litre of a solution of known strength, and 200 cc. of this solution were withdrawn and boiled in an open conical flask for a certain period of time. The amount of nicotine remaining in the solution after boiling was estimated by direct titration with half normal Sulphuric Acid, using cochineal as indicator.

Three distinct series of experiments were performed, solutions containing approximately .1 per cent., .2 per cent. and .3 per cent nicotine respectively.

The results obtained are given below in tabulated form and are also represented graphically by means of curves showing the relation between nicotine remaining in the solution and the time of boiling.

.1% *Solution of Nicotine in Water:*

Time of boiling.	*Nicotine in solution after boiling.*
No boiling	.101%
5 minutes	.085%
10 minutes	.07087%
20 minutes	.0526%
30 minutes	.0364%

.2% *Solution of Nicotine in Water :*

Time of boiling.	*Nicotine in solution after boiling.*
No boiling	.1944%
10 minutes	.1377%
15 minutes	.1158%
30 minutes	.0931%

.3% *Solution of Nicotine in Water :*

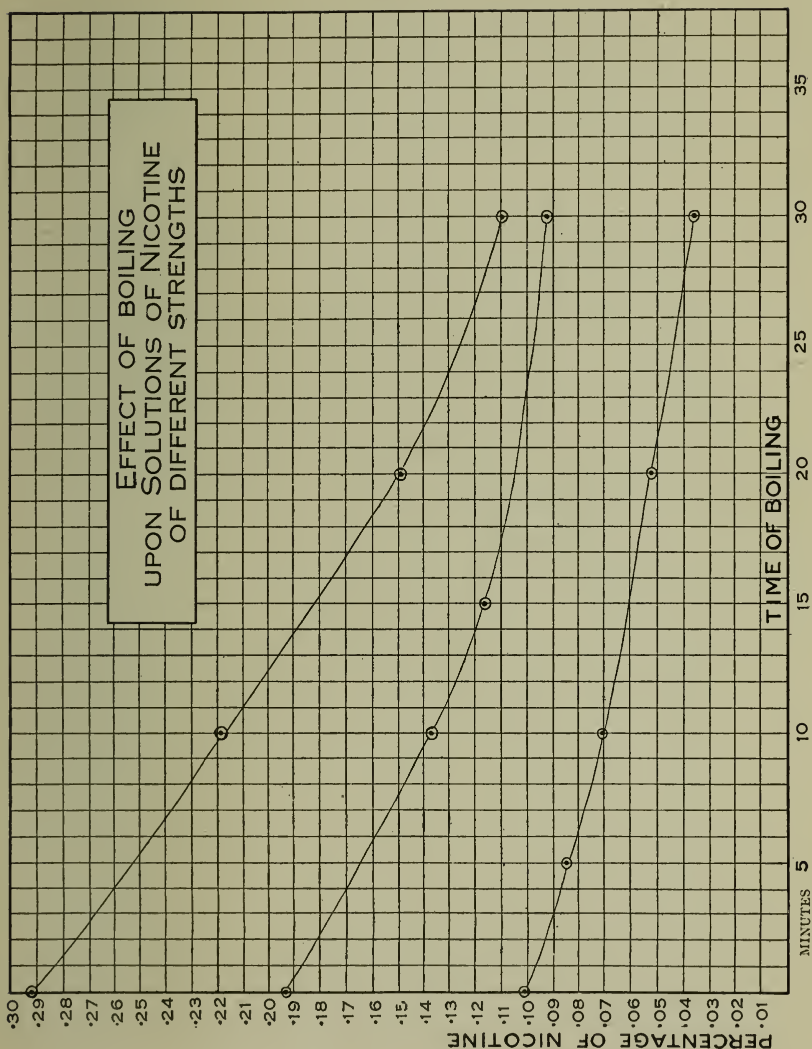
Time of boiling.	*Nicotine in solution after boiling.*
No boiling	.2916%
10 minutes	.2187%
20 minutes	.1498%
30 minutes	.1093%

We see from these figures and curves that a very distinct loss of nicotine takes place on boiling its aqueous solutions in air for any length of time. As would be expected, the stronger the solution the greater the loss of nicotine in the first few minutes' boiling, also, in each case, the loss of nicotine is greater in the first few minutes than after the boiling has been continued for some time.

While the results obtained experimentally and given above were given by solutions of *pure* nicotine, there is no doubt that the nicotine present in an aqueous extract of tobacco would be lost on boiling in the same way, as even if the nicotine were partly present in the form of salts, such as the citrate and malate, these salts are readily hydrolysed by water, with liberation of the free alkaloid, which would then be volatilised in the steam.

In preparing solutions of nicotine for spraying or dipping purposes by extraction of the leaf with water, it is therefore of the greatest importance that the water be not *boiled* with the tobacco for preparation of the extract, as a considerable loss of the alkaloid will always result from such treatment.

Even if the water be not boiling, but at a temperature sufficiently high to give off vapour in any considerable amount


EFFECT OF BOILING
UPON SOLUTIONS OF NICOTINE
OF DIFFERENT STRENGTHS
TIME OF BOILING
MINUTES
5
10
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PERCENTAGE OF NICOTINE
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(*i.e.*, above 60° C.), then this same objection applies, although the actual loss of the nicotine may not take place to such a large extent. Warm water below 60° C. is therefore recommended for this purpose, as although the actual extraction takes a little longer, practically all the nicotine will be ultimately obtained in solution in the form in which it is required for immediate use, and there will be no loss due to volatilisation.

B.—The extraction of nicotine by water at the ordinary temperature from samples of air-dried leaves containing different percentages of the alkaloid.

While, as shown in the experiments described above, the nicotine is practically entirely removed from leaves containing 4.6 per cent. of this substance, it was thought that it might not be impossible that a complete extraction could not be obtained with other samples containing either a very high or a very low nicotine percentage. The solution of this question is of importance, as the nicotine content varies enormously, from nine per cent. to practically nil, in the leaves of different species of the plant, and also in different parts of the same plant. If it were found that a tobacco of medium strength (3 to 4 per cent. nicotine) gave good results on extraction, it would doubtless be of advantage to mix any low percentage tobaccos with any that might be obtained above 4 or 5 per cent., in order to avoid working with tobacco leaves of either very high or very low nicotine content, and also to avoid the preparation of large volumes of a weak solution, as would result if a low percentage tobacco were extracted alone.

Experiments were carried out with different leaves of varying nicotine content, the method of procedure being the same as in the former series of experiments, excepting that only 200 cc. of water to each ten grams of powered leaf were employed.

These 200 cc. were used in two equal portions of 100 cc. each, in order to wash the extract from the leaf, as explained before. The temperature of the water was about 15° C. in all the following experiments.

Percentage of nicotine in air-dried leaf before extraction.	*Percentage of nicotine in leaf after extraction.*	*Percentage of nicotine in solution obtained.*
8.37	.01	.418
7.45	.00	.372
4.67	.00	.233
3.70	.00	.185
1.11	.01	.055
0.49	.00	.024

It was found that the quantity of water used, 200 cc., was the least quantity that could be employed to get a mixture sufficiently liquid to allow of its being filtered; consequently we see that with a tobacco below about 3 per cent. the strongest solution obtainable is still too weak to be employed directly as a spray, and would therefore have to be mixed with a stronger solution before use in order to bring the percentage of nicotine present up to at least .075. The same result would be obtained by using, instead of water, one of the weak nicotine extracts for treatment of a further quantity of tobacco. It seems, however, that the best plan is neither of these, but consists in mixing the tobaccos *before extraction*, so that the average nicotine content of the mixture will be about 4 per cent.; in this way the handling of large volumes of liquid in a definite order is obviated, while the product treated is always of the same strength with regard to nicotine, an obvious advantage where the work has to be carried out by unskilled labour.

For this reason, the instructions given at the end of this paper with regard to the method of preparation of nicotine extract of a suitable strength for spraying, have been calculated on the basis that the tobacco leaves used contain 4 per cent. nicotine.

Extraction of Nicotine from Tobacco Leaves on the Large Scale.

The extractions described above were all carried out on an experimental laboratory scale, and with the tobacco finely ground, and the results obtained show the most efficient extractions of nicotine that is secured under the most advantageous circumstances, using water as the solvent. Owing

to the satisfactory results obtained, the use of other solvents, such as dilute Sulphuric Acid, Soap Solution, etc., was not experimented with on the small scale.

LARGE SCALE EXPERIMENTS.

The next series of experiments was carried out with much larger quantities of material, and under more practical conditions, with the object of making use of the results above obtained for determining the best conditions applicable to the extraction on the large scale.

The leaves were dried as before, but instead of being finely ground in a mill were either roughly crumbled in the hand, or else not broken up at all. This tobacco was then treated under different conditions with water, hard and soft, and also in two experiments, with soap solutions. The periods of extraction were also varied.

The nicotine solutions so obtained were used in field experiments for the spraying of different samples of aphis, the results being appended.

With regard to the large scale experiments, it must be remembered that the completeness of extraction of nicotine depends largely upon the state of division of the leaves, consequently one would not expect such a high extraction with roughly crumbled leaves as was obtained with the finely ground article on the small scale.

First Large Scale Extraction.

Three pounds of tobacco, containing 3.5 per cent. nicotine, and coarsely crumbled in the hand as mentioned above, were placed in a five-gallon tub, and three gallons of water at a temperature of 60° C. were added.

The mixture was well stirred for fifteen minutes, when the liquid was poured off into a twenty-five gallon barrel, provided with a piece of fine sacking tied over the top to act as a filter.

After pouring off as much liquid as possible, the wet leaves were also poured into the filter, and well squeezed and kneaded until all the liquid possible was removed.

The semi-extracted leaves were then replaced in the small tub, treated with another three gallons of water at 60° C., stirred for quarter of an hour as before, and the liquid poured off and the leaves squeezed into the barrel as previously.

The same treatment was again applied for a third time, as much as possible of the liquid adhering to the leaves was removed, these leaves being set aside for ultimate analysis.

The same process was carried out for other lots of 3 lbs. of tobacco leaves, until twenty-five gallons of tobacco solution had been prepared.

A sample of the extracted leaves was then analysed, after drying, and the nicotine content was found to be .5 per cent. showing a removal of 3.5—.5=3 per cent. on the weight of leaves taken.

The strength of the solution with regard to nicotine was therefore $\frac{3}{100}$ of 3 lbs. nicotine per 9 gallons or 90 lbs. water. $=\frac{9}{100}$ lbs. per 90 lbs. solution=.10 per cent.

It was found that 3 lbs. of leaves could not be satisfactorily treated with less than 3 gallons of water at a time, otherwise the consistency of the liquid was too great to allow of ready stirring. This proportion of water to leaves was adhered to throughout the large scale experiments, and in every case also the extraction was carried out in three stages, as described above.

The somewhat considerable amount of nicotine still remaining in the leaves after extraction shows that the above method of treatment is not satisfactory. As greater quantities of water would give a solution too dilute for ordinary spraying purposes, the time of extraction was lengthened, as it was hoped that a more complete removal of nicotine might be effected in this way. (See experiment 2 and 3.)

The .1 per cent. nicotine solution obtained above was used for spraying aphis on apples, currants and hops. Even without the addition of soap, it was found to be most efficient on green apple aphis, currant aphis, and hop aphis, producing a mortality of 100 per cent., while it had no effect whatever on woolly aphis. On young apple trees infested with leaf-curling aphis the results were variable, owing to the difficulty of bringing the liquid into close contact with the insects. When the insects were sufficiently exposed to be wetted, however, they were found to be killed almost immediately.

For further field experiments, 10 volumes of the solution were diluted up to 13 volumes by the addition of water, giving a solution of $\frac{10}{13}$ of .1 per cent. =.077 per cent.

This weaker solution was found to be fatal to apple leaf-curling aphis, when it was possible to bring the liquid into contact with the insects.

With hop-aphis also, the results obtained were extremely satisfactory, a mortality of 100 per cent. of the insects being obtained in every case.

Second and Third Extractions.

The nicotine (.5 per cent.) still remaining in the leaves after extraction, according to the first series of experiments described above, is decidedly too high a proportion for economical work.

The fact that *all* the nicotine can be removed by water and by water alone, was conclusively shown in the laboratory experiments. Of necessity, however, the large scale extraction is less efficient, owing to the fact, as mentioned above, that the leaves, instead of being finely powdered, are in comparatively large pieces when treated.

Attempts were therefore made to secure a more complete removal of the nicotine, by allowing the leaves to remain in contact with the water for longer periods of time.

In experiment 2, leaves were taken containing 2.6 per cent. nicotine, and were treated with water at 60° C. in the same proportion and in the manner described above for experiment 1, the only difference being that the time of each extraction was extended to half-an-hour, the mixture being thoroughly stirred at intervals during that time.

A much more satisfactory extraction was obtained, only .075 per cent. nicotine being left in the leaves after treatment.

In experiment 3, the time of each extraction was increased to one day, the other details of the experiment being exactly similar to those in experiments 1 and 2. A still further removal of nicotine was secured in this case, the residue in the leaf after extraction amounting to only .056 per cent.

The time of extraction was not increased to beyond one day, as the difference between the results of experiments 2 and 3 did not seem to warrant a longer treatment.

The solutions obtained from experiments 2 and 3 were diluted with the necessary quantity of water to give a liquid containing .075 per cent. nicotine, and this solution was

then sprayed on about half a rood of seedling hops infected with aphis. The results were most gratifying, a complete mortality of the pest being obtained.

Fourth Extraction.

The effect of using soft water *at the ordinary temperature* was investigated. The temperature of the water employed was 15° C., otherwise the experiment was performed similarly in every way to that described for the third extraction.

The extraction was found to be only half as efficient in this case, the leaves still retaining .105 per cent. nicotine, as against .056 per cent. obtained in the third extraction.

Fifth, Sixth, Seventh, Eighth and Ninth Extractions.

Hard water was substituted for soft, and the extractions at 50° C. and also at the ordinary temperature were investigated. Little difference was noted as the result of using hard water, except in experiment 9, in which a smaller extraction was obtained than was expected from comparison with the third extraction.

Tenth and Eleventh Extractions.

In these experiments a variation was made in the nature of the solvent, a 2½ per cent. solution of soft soap in soft water being employed.

A more efficient extraction was obtained, the residue containing only .016 per cent. nicotine after treatment with the soap solution.

This result is what would be expected on theoretical grounds, as a solution of soap possessing an alkaline reaction is able to liberate the nicotine in a free state from any salts (malate, citrate, etc.) in which it may be present in the leaf, and, as is well known, this free nicotine is considerably more soluble than when combined in the form of salts.

In spite of the fact, however, that a soap solution is more efficient than water alone, the slight difference in the strength of the nicotine solution so obtained, .0861 per cent. instead of .0832 (see table on following page), does not seem to warrant the additional trouble and expense entailed in the preparation of the soap solution. If however, as is often the case, soap is to be added to the liquid before spraying, then it

would obviously be good policy to dissolve the soap before extracting the tobacco leaves, rather than afterwards; as a slightly greater proportion of the nicotine would thus be obtained.

GENERAL CONCLUSIONS FROM LARGE SCALE EXPERIMENTS.

1.—There is no need for the use of specially prepared acid or alkaline solutions in the removal of nicotine from tobacco leaves, ordinary water (hard or soft) at the ordinary temperature effecting an extraction of 96 per cent. of the total alkaloid present.

2.—The water should be employed in the proportion of one gallon per one pound air-dried leaves, and the latter should be treated with three successive quantities of water, in the same proportion. From every one pound air-dried leaves there will thus be obtained three gallons nicotine solution, which will generally require dilution to a certain extent before use as a spray. In the case of leaves containing 4 per cent. nicotine, the necessary dilution of the resultant liquid will be attained by the addition of two parts water to three parts solution.

3.—Although the cold water may be employed for extraction, a better result is obtained by the use of hot water. The temperature of the hot water should not be above 60° C. (140° F.), as otherwise a loss of nicotine may result through volatilization in the steam (pp. 334, 335 and 336).

4.—One day for each extraction, making three days in all for each lot of leaves, is the length of time recommended, although this time can be reduced without entailing considerable loss of nicotine. As the results given in the table on page 45 show, the most rapid extraction takes place during the first half hour of treatment, 97 per cent. of the total nicotine present being removed by water at 60° (140° F.) after three successive treatments for this length of time.

5.—A 2½ per cent. solution of soft soap extracts 1 per cent more nicotine at 60°C (140° F.) than does soft water at that temperature. Hence if soap is to be ultimately used in the spray, as is often the case, a slight advantage is gained by dissolving the soap in the water before rather than after extraction of the nicotine.

Number of Experiment.	Solvent Employed.	Temperature of Solvent.	Amount of Solvent used per 1 lb. Tobacco.	Time of each Extraction.	Tobacco in Leaf before Extraction.	Tobacco in Leaf after Extraction.	Percentage of Nicotine in resulting Solution.	Percentage of Nicotine removed from Leaf.
					Per cent.	Per cent.		
1	soft water	60° C. or 140° F.	3 gallons	$\frac{1}{4}$ hour	3.5	.5	.10	86
2	soft water	,,	,,	$\frac{1}{2}$ hour	2.6	.075	.0842	97
3	soft water	,,	,,	1 day	2.6	.056	.0848	98
4	soft water	15° C. or 60° F.	,,	1 day	2.6	.105	.0832	96
5	hard water	,,	,,	6 hours	2.6	.405	.0732	84
6	hard water	,,	,,	6 hours	2.6	.405	.0732	84
7	hard water	,,	,,	1 day	2.6	.12	.083	96
8	hard water	,,	,,	1 day	2.6	.14	.082	96
9	hard water	50° C. or 120° F.	,,	6 hours	2.6	.17	.081	94
10	$2\frac{1}{2}$ % soap solution	60° C. or 140° F.	,,	1 day	2.6	.016	.0861	99
11	$2\frac{1}{2}$% soap solution	60° C. or 140° F.	,,	1 day	2.6	.016	.0861	99

Directions for Preparing .075 per cent. Nicotine Solution from Tobacco Leaves, for Use as a Spraying Agent.

For every acre to be sprayed, take 100 lbs. air-dried tobacco leaves, stir thoroughly with 100 gallons water (warm, if possible), and allow to stand for one day. Run the extract from the leaves, and extract the latter twice again similarly with 100 gallons water.

The 300 gallons extract so obtained are made up to 500 gallons by addition of water.

This will give a solution slightly stronger than .075 per cent. of nicotine, assuming there were 4 per cent. nicotine in the tobacco leaves employed. (See page 337.)

The Keeping Properties of the Tobacco Extracts.

A sample of the liquid obtained by the extraction of tobacco leaves in one of the above experiments was kept in a vessel uncorked for a length of time, in order to determine whether any fermentation was set up in the liquid, or whether a formation of mould took place on the surface.

It was found that after a few days a scum appeared on the surface, gradually increasing in thickness until after a few weeks it was sufficient in amount to prevent the free passage of such a liquid through the fine nozzle of a spraying machine.

Experiments were therefore carried out to test the effect of the addition of quantities of different antiseptic agents on the prevention of the formation of this scum.

Six samples of a tobacco extract were placed in small bottles, loosely corked, and were treated as follows :

No. 1.—Untreated.

No. 2.—A few drops of toluene added.

No. 3.—A small crystal of phenol (carbolic acid) added.

No. 4.—A few drops of chloroform.

No. 5.—A small quantity of boric acid.

No. 6.—A few drops of formalin.

The samples were then set aside for two months, the corks being loosened from time to time to allow of free access of air.

It was found that samples 1, 2, 3, 4 and 5 all developed varying amounts of scum, the quantity being greatest in the

untreated sample. In the case of formalin, however, it was found that the formation of the scum was entirely prevented.

It would therefore evidently be advisable to add small quantities of formalin to tobacco extracts that are to be kept for any length of time. This formalin would have no deleterious effect upon the efficiency of the nicotine for spraying purposes, and if present in sufficient quantity would have an additional insecticidal value.

As to whether this formation of mould on the surface leads to any loss of nicotine in the solution was not determined.

Legislation Regarding the Growing of Tobacco in Great Britain.

The ultimate aim and object of the experiments carried out at this College, with regard to tobacco growing and nicotine extraction, is to make it possible, in the future, for every horticulturist and nurseryman, and in general, any one requiring nicotine for insecticidal purposes, to set aside a small area of his land for tobacco cultivation, to grow upon that land some rank species of tobacco of high nicotine content, and to extract the nicotine from the dried leaves, so as to prepare cheaply and economically a solution of the alkaloid of suitable strength for the purpose required. In this way a considerable saving would be effected by those who now use nicotine, but who have to purchase the pure article at a high price, also the great advantages resulting from the general use of nicotine would be available to those who at present cannot afford to purchase the substance in a concentrated form.

Unfortunately from this point of view, however, it is at present illegal for anyone and everyone to grow tobacco in this country, and the few favoured persons and institutions to whom this permission is granted have had to undergo considerable trouble to obtain that permission, and even when it is obtained, have to submit to a very close surveillance and to conform to very strict regulations throughout the whole period of growing and harvesting the tobacco crop; and finally the entire crop has to be secured under lock and key, and even the smallest portion cannot be withdrawn unless in the presence of an Excise Officer.

Naturally, these restrictions render absolutely impossible at present the widespread growth of tobacco in this country, and will continue to do so until the legislation on this matter has been considerably modified, and the cultivation of tobacco *for economical purposes* is allowed to be carried out free of observation by, or notification to, Government officials.

Undoubtedly the Government is wise to safeguard its own interests in this way. The duty imposed on tobacco imported into this country brings in over £17,000,000 a year, a notable increase to the Inland Revenue, and any change in legislation which might endanger this income will have to be considered minutely and in detail. Probably over 99 per cent. of this imported tobacco is used for smoking purposes, and hence must be regarded as a luxury and not as a necessity, and is taxed accordingly. It is not, however, with regard to tobacco for smoking purposes that a removal of the duty would be an advantage, but with regard to tobacco for economical purposes, *viz.*, the destruction of insect pests, the damage done by which costs the country many thousands of pounds per annum. It is for this purpose alone that the tobacco grown duty free in Great Britain would be employed, and from which a removal of the present restrictions is asked.

These and various other facts in connection with the point at issue were brought to the attention of the Government by a Commission of Fruit Growers and others in May, 1911,* as a result of which an official notification was made that a reduction or removal of the duty on home-grown tobacco *intended for economical purposes only* would not be impossible, if some suitable means were suggested whereby the use of such tobacco for smoking purposes could be entirely prevented, and provided that the Government was satisfied that the precautions taken would be sufficiently rigid.

That is where the matter stands at present, and until some method of rendering the home-grown tobacco unsmokeable, to the satisfaction of the Legislature, has been applied, the present restrictions attending the growth of tobacco in this country will not be relaxed.

* For the decision arrived at by the Government representative on this occasion see Mr. Garrad's report on page 26.

The Denaturing of Tobacco.

A similar difficulty to that mentioned above occurred some years ago in the case of alcohol, the duty on which was so excessive as to render impossible its use for many industrial purposes for which it was required. The difficulty was surmounted by denaturing the spirit to be used for industrial purposes, whereby it was rendered unfit for human consumption, and, moreover, could not be readily freed from the impurity added.

A similar method should be applied in the case of tobacco, and provided a really efficient denaturant were discovered, there is no doubt whatever that in the future tobacco could be used duty free for industrial purposes, in the same way that denatured alcohol (methylated spirit) is employed duty free to-day.

To decide upon a suitable denaturant is not, however, such a simple matter as appears at first sight. In addition to rendering the actual tobacco leaves unsmokeable, the extraction of pure nicotine from these leaves must be rendered impossible, otherwise this nicotine could be employed for mixing with other substances, with production of a " tobacco " which might be used for smoking purposes.

Again, the leaves left after the extraction of the nicotine and which, without any qualms of conscience might still be regarded as tobacco, could be used for adulterating other tobaccos, and the mixture employed for smoking.

Any proceedings such as these would result in a direct loss to the revenue, for, in any one of these cases a true tobacco containing nicotine would be produced, and which, moreover, would have paid no duty.

A substance, or mixture of substances, has therefore to be decided upon with which the leaves can be treated when still growing, or else, immediately on harvesting, whereby not only are the leaves themselves rendered directly unsmokeable, but the nicotine obtainable from those leaves produced in a denatured condition, and also the extracted leaves themselves rendered unsmokeable, or at least recognisable in any mixture to which they might be added.

It is unlikely that one substance alone can be used which will fulfil all these conditions. It is more likely that a mixture

of different bodies, *e.g.*, turpentine, and some light organic dye, or soluble copper salt, will be found to give better results.

In the case of turpentine and eosin (a bright red dye), for example, the leaves will be coloured red, even after removal of nicotine, and would in this way be readily recognisable, while the turpentine would be removed with the nicotine when the latter substance were separated from the leaves, acting as a denaturant to it.

Field Experiments on Denaturing.

On October 2nd a plot of tobacco (Nykerke) consisting of twenty rows, twelve plants in a row, was treated as follows :

(*a*) Six rows (72 plants), 36 square yards, were sprayed with one-and-a-half gallons 10 per cent. copper sulphate solution, and then immediately after with half a gallon of turpentine (=67 gallons turpentine and 200 gallons 10 per cent. $Cu.So_4$. *per acre*).

(*b*) Two rows (24 plants), 12 square yards, were sprayed with a mixture of one-sixth gallon turpentine and water in which a red dye (safranine) had been dissolved (=67 gallons turpentine *per acre*).

(*c*) Six rows (72 plants) 36 square yards, were sprayed with one gallon 5 per cent. copper sulphate solution, and then with one-third gallon turpentine. (=134 gallons 5 per cent. $Cu.So_4$. and 45 gallons turpentine *per acre*).

(*d*) Six rows (72 plants), 36 square yards, were sprayed with one gallon 10 per cent. copper sulphate solution (=134 gallons 10 per cent. $Cu.So_4$. *per acre*).

A fair amount of scorching of the leaves after treatment with turpentine was noticed.

On October 3rd, there having been no rain in the meantime, the leaves from the different plots were picked, dried at a temperature of 60° C. in an oast and examined in order to determine whether the denaturants added were capable of easy detection, and also whether nicotine, free from turpentine, could be easily separated from the leaves.

Detection of Copper in samples from (*a*), (*c*) and (*d*).

The sample leaves taken were cut up into small pieces, and stirred for a few minutes with cold water, in the proportion of one pound tobacco to one gallon water.

The solution so obtained was tested for copper by means of sulphuretted hydrogen and potassium ferrocyanide. The leaves were again treated with successive quantities of water, and the solution tested, until all the copper sulphate had been removed from the leaves.

(*a*) Sample had decided smell of turpentine. Even after the third extraction with water, the presence of copper was easily detected in the solution.

(*c*) Decided smell of turpentine. Faint coloration of solution by sulphuretted hydrogen after second extraction. No copper detected in solution after third extraction.

(*d*) Copper readily detected in solution from third extraction.

On treatment of sample (*b*) with water, no dye was found to be dissolved from leaf by solution. The leaf smelt strongly of turpentine.

Removal of Turpentine Resins with Nicotine on Ether Extractions.

Samples (*a*) (*b*), and (*c*) were treated with ether for six hours in a Soxhlet extractor. On distilling off the ether from extract it was found that the nicotine had a strong smell of turpentine resins. All the turpentine resins were removed from the leaves after extraction for six hours, the time required for complete removal of the nicotine.

Distillation in Steam of Nicotine and Turpentine Resins.

The solution of nicotine and turpentine resins obtained by the extraction of samples (*a*), (*b*) and (*c*) with ether, were taken up with dilute Caustic Soda Solution, after removal by the ether on the water bath.

The alkaline solutions thus obtained were then distilled in steam. It was found in each case that the turpentine resins came over with the nicotine, the distillation smelling strongly of turpentine.

The Burning of the Denatured Tobacco.

Samples of the denatured tobaccos (*a*), (*b*), (*c*) and (*d*) were cut into thin shreds, were placed in clay pipes and a current of air drawn through the pipes by means of a filter pump.

The tobacco was then ignited and the smoke drawn into a conical flask inserted between the filter pump and the pipe.

In every case the smoke produced had a most pungent odour.

Conclusions from Experiments on Denatured Tobacco.

1.—The spraying of the growing leaves with fifty gallons of turpentine per acre renders the tobacco absolutely unsmokeable.

2.—The presence of copper on the leaves treated with 150—200 gallons 10 per cent. copper sulphate solution per acre can be detected after washing three times with water, and in the case of 5 per cent. copper sulphate solution, after two washings.

3.—The nicotine in the leaves cannot be separated from the turpentine resins also present by any of the ordinary methods of nicotine extraction used by the manufacturer (*e.g.* ether extraction and steam distillation).

In the case of sample (*d*), untreated with turpentine, the nicotine could be prepared in a pure state.

4.—Dyes are of no use from the point of view of rapid detection of denatured leaves, as the colour is not discernible on the brown scorching produced by the action of the turpentine.

The best denaturant for the tobacco therefore seems to be ten per cent. copper sulphate solution, and turpentine, applied separately by spraying on the growing leaves. 150—200 gallons of the copper solution, and fifty gallons of turpentine per acre sprayed seem to be sufficient for ordinary purposes of detection. As will be seen, however, the use of turpentine would be quite impossible on a commercial scale owing to the high price of the substance.

Cost of Spraying Mixture per acre.

200 gallons copper sulphate (10 per cent.) containing 200-lbs. coffee sulphate at 3d. per lb ..	£2 10 0
50 gallons turpentine at 5s. per gallon ..	£12 10 0
Total cost of materials	£15 0 0
Cost of copper sulphate alone	£2 10 0

It will be seen from the above figures, that the use of turpentine as a spray is quite prohibitive owing to the

excessive cost. Copper sulphate however, might very well be used alone, as spraying with a 10 per cent. solution of this substance would, as mentioned above, render the leaves so treated immediately recognisable by a simple chemical test. The cost of material in this case is also not sufficiently high to prevent its use, even allowing the probably excessive estimate of ten shillings per acre for the cost of the labour of spraying.

The impossibility of using turpentine is unfortunate, as although the use of copper sulphate alone denatures the leaves, and renders their detection a matter of no difficulty, nicotine can be prepared from these leaves in a pure condition. Indeed it seems decidedly doubtful whether there is any substance that would denature the *nicotine*, and which would at the same time be sufficiently cheap to allow of its use for this purpose.

The practical details of denaturing therefore require thoroughly working out on the large scale, although the above experiments seem to show that copper sulphate is one of the few substances that combine efficiency with cheapness.

ON NITRATE OF LIME TREATED WITH MINERAL OIL.

By S. J. M. Auld, D.Sc. and G. Smith.

Nitrate of lime, one of the newer artificial nitrogenous manures, is gradually obtaining a very extended application. As is well known, it is prepared from the atmospheric nitrogen by a modern extension of the original Cavendish method, and can now be obtained at prices which render it a serious competitor to the older nitrogenous artificials. Experiments have shown it to be equal, and possibly the superior, of nitrate of soda. It possesses one great disadvantage, however, which largely discounts its advantages and prevents its complete success. It is extremely hygroscopic and attracts water from the atmosphere to an extent equalled only by calcium chloride.

Nitrate of lime is easily the most hygroscopic manure in use (See Brownless, J. Agric. Sc., IV.). It rapidly becomes moist and sticky, and in this condition is extremely difficult to handle and distribute. An enterprising firm has endeavoured to combat this drawback by mixing the fertilizer with an oily material in the hopes of keeping the calcium nitrate from the air, and at their invitation we have carried out experiments to test the efficacy of the treatment. The idea of using oil seems very sound if sufficient of the protecting agent can be used completely to envelop the fertilizer particles. Unless this is done the attraction of moisture from the air would seem to tend towards the disruption of the films and the agglomeration of the oil into particles, in which condition the effect would be small.

The points tested were the following :—

(*a*) The retardation of the absorption of water.

(*b*) The effect on the rate of solubility.

(*c*) The effect of the oil on the manurial value of the nitrate of lime.

(*d*) The minimum amount of oil necessary.

The sample as received from the manufacturers consisted of a dark brown almost powdery material, apparently homogeneous and in a condition easy to handle. Exposed to the atmosphere under ordinary conditions it gradually absorbed water, but apparently not so rapidly as the untreated material.

Estimation of the Oil.

The oil was estimated in the usual manner by extraction with petroleum ether in a Soxhlet apparatus. Using every precaution to obtain constant results, the amounts of oil extracted were found to vary considerably, probably owing to the different sizes of particles. From the analytical point of view, at any rate, the mixing of the oil was not all that could be desired. The quantities of oil found varied from 1.42 per cent. to 1.73 per cent, average, 1.51 per cent.

The oil extracted was dark coloured and viscid. Its smell and other characteristics were those of a heavy mineral oil. The residue after removal of the oil was dark coloured—almost black—due probably to impurities in the oily material used. The material was remarkably hygroscopic and was found on analysis to contain an insoluble black substance. The soluble material was practically devoid of chlorides and apparently consisted of almost pure nitrate of lime. The small amount of black residue was not at all hygroscopic in character and consisted largely of carbon, calcium carbonate, and an insoluble silicious residue. The hygroscopicity was, therefore, due to the nitrate alone.

Effect of the Oil on the Rate of Absorption of Water.

A preliminary experiment comparing the oiled material with an ordinary commercial sample of nitrate of lime gave rather equivocal results. For definite comparative values measurements were carried out in two distinct ways. Comparison of the oiled sample was effected with the material from which the oil had been removed and also with the nitrate of lime prepared from it. The latter was obtained by dissolving in water, filtering and evaporating the solution to a thick paste on the water bath. The material was then allowed to cool to a solid mass in a vacuum dessicator, and when powdered up and re-dried under the same conditions closely resembled the commercial substance.

Series I.—10 grs. each of the oiled, ether-extracted, and recrystallized samples were mixed with an equal volume of sand and exposed in open dishes to the air under a large bell jar in which was placed a beaker of water to keep the enclosed atmosphere of a constant moisture content. Weighings were made once a day. The results obtained, showing the amounts of water absorbed, are represented graphically in the accompanying curve (Fig. 1).

The oiled sample was distinctly superior to the recrystallized one throughout the experiments but in the initial stages was inferior to the extracted material. It was much better in the long run, however, and did not become " liquid " until three days later.

It will be noted that the samples without oil absorb water much faster after they have become liquid ; but in the case of the oiled sample the curve is nearly straight. Apparently the vapour pressure of the solution is distinctly lower than that of the solid or pasty mass, since the surface exposed will become smaller after liquefaction. After the film or coat of oil has been broken by the particles becoming wet, the remainder acts like the untreated material as is shown in the graph by the lines running almost parallel after liquefaction.

The method of exposing the material in open dishes was eventually discarded. It is liable to give varying results, owing to the difficulty of controlling the amount of surface exposed, but is comparable to the conditions of storage of the manure and gives valuable indications of the mechanical condition of the manure at various times. The oiled material becomes pasty or liquid much more slowly, apart from the amount of water absorbed, and this, after all, is the more important factor.

Series II.—More comparative results of the water absorption were obtained by passing moist air through the material mixed with a porous material in long tubes. Sand was not sufficiently porous, and eventually powdered coke (in particles varying in diameter from 1 to 3 mm.) was used. This worked excellently. Tubes of 18 cm. length and 1.75 cm. diameter were packed with the mixed material, and 10 litres of moist air were drawn through each tube daily by means of an

FIG. 1

Hygroscopicity of oiled, recrystallised, and extracted samples
Mixed with sand and exposed in open dishes.

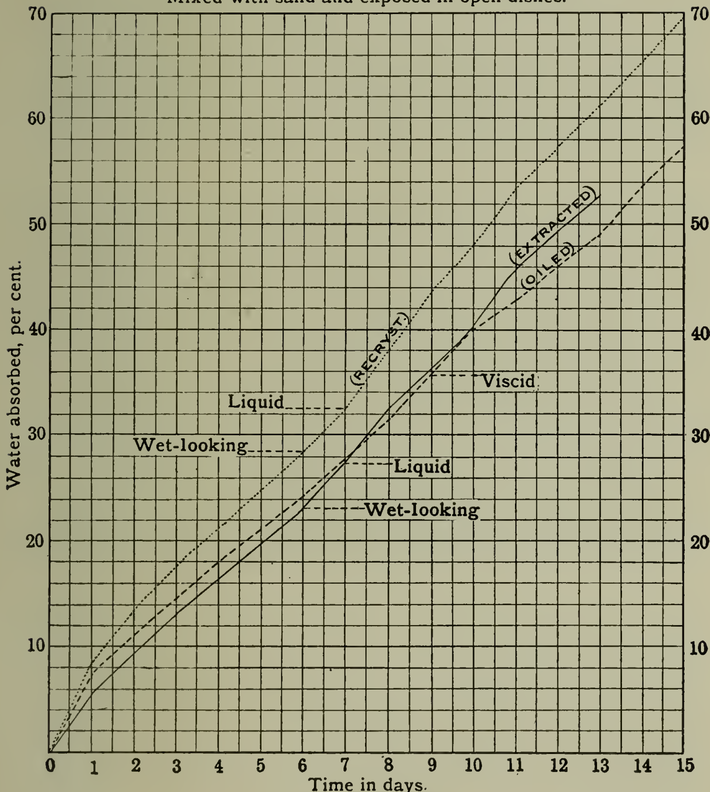

FIG. 2

Hygroscopicity of oiled and recrystallised samples.
Water absorbed from 10 litres of moist air per day.

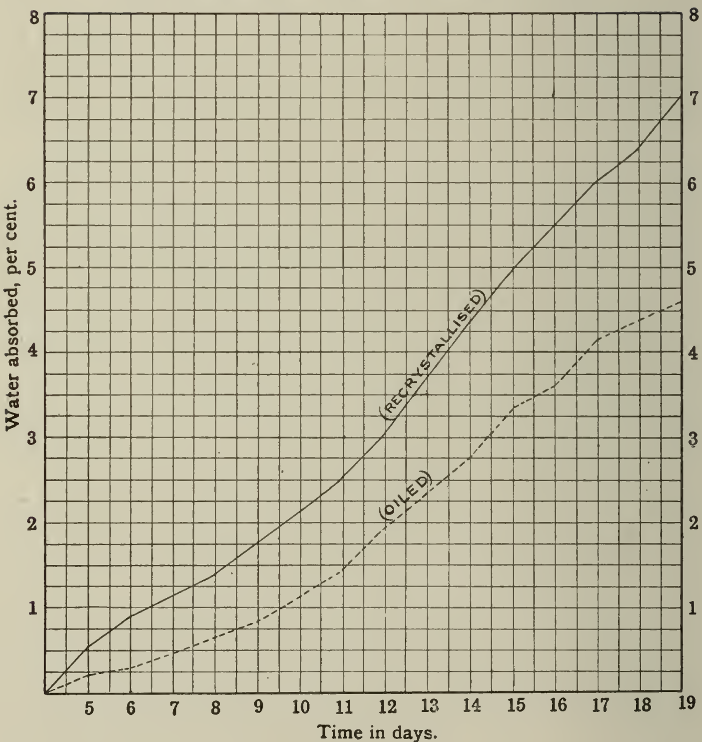

FIG. 3. TOMATO PLANTS MANURED WITH NITRATE OF LIME.

1, Oiled Nitrate. 2. Ordinary Nitrate. 3. Control.

aspirator. The air was saturated with moisture to the same extent by passing it through the same height of water in each case, and using inlet tubes of identical diameter. The experiments were extended over twenty days, and the results are graphically shown in Fig 2. On the whole the results are similar to those obtained at the commencement of Series I, the oiled sample showing up rather better, if anything.

Effect of the Oil on the Fertilizing Value of the Manure.

Pot cultures were carried out with tomato plants. Thirteen uniform young plants about two inches in height were selected and potted out in 6-inch pots. The soil used had not been manured for three years, and previous to the experiments was mixed with a little sand to suit the plants. Throughout their growth care was taken to prevent the addition of excess of water which might wash out the nitrate.

Four pots each were used for the oiled sample and the recrystallized nitrate, and one set of four pots was used as a control without manure. The plants were allowed to grow a week in their new conditions without the application of nitrate, which was then added in solution at the rate of 2 cwt. per acre.

Both the manured series of cultures showed an increased growth shortly after application, and in a month blooms were shown.

After six weeks growth the plants (see Fig. 3) were cut and weighed. The unmanured plants were of a bad colour and straggling, whilst the other two were well grown with dark normal foliage. Two of the plants treated with the nitrate alone were actually in flower when cut. The plants were cut about half way between the scar of the cotyledon and the first leaf. The roots in each case had reached the bottom of the pot and were quite normal.

The total weights were :—

Unmanured	.. 95 grs.	Average	23.7
Oiled Nitrate	127.6 grs.	,,	31.9
Recrystallized Nitrate	126 grs.	,,	31.5

The two weights of the nitrated cultures may be regarded as identical, and the small quantity of oil present in the treated manure has apparently no marked ill effect.

Whether large quantities of oil would act deleteriously either by acting as a toxic substance or by preventing the assimilation of the manure is not certain. With manures other than nitrates, the case is different, since a disruption in the soil is frequently necessary before they can be assimilated. On the other hand an experiment carried out by H. G. Söderbaum* with oiled cyanamide also gave no serious results from the presence of the oily substance.

It is frequently believed, however, that oil in a manure acts deleteriously in the soil, but there is no positive evidence on the subject. The matter becomes of importance, for example, in fish manures where the oil content, may reach 6 per cent., or in hair wastes, a sample of which, examined in the department contained 14 per cent. of oily material (see p. 254). In such cases the oil may well prevent the rapid decomposition of the material by soil bacteria as well as by introducing substances of a type which have been recently shown to act as toxines to plants.

The effect of the small quantity of oil on the solubility of the nitrate of lime is inappreciable, and it is rather to be deplored, since any method of preventing the washing out of nitrates from the soil would be welcomed on account of the present necessity of using such fertilizers only as top dressings.

Conclusions.

The treatment of nitrate of lime with small quantities of mineral oil is distinctly beneficial, decreasing the hygroscopicity and retarding the liquefaction of the fertilizer, and no evil results are caused to plant growth by the presence of mineral oil to the extent of 1.5 per cent.

It is desirable that the effects of larger quantities of oil be tried since the decrease in the hygroscopicity and the keeping powers of the fertilizer might profitably be still further augmented.

The mechanical condition and ease of handing the nitrate of lime is greatly improved by the treatment with oil.

* Exp. St. Record, 1909, 23.

REPORTS

FROM THE

BOTANICAL DEPARTMENT.

NOTE ON THE "DIPPING" OR "WARM BATH" METHOD OF FORCING PLANTS.

By S. T. Parkinson, B.Sc.

Further experiments on forcing plants by the method described in last year's *Journal* have been carried out this year. It seems unnecessary to give details of all these experiments as the results on the whole were simply a confirmation of those previously obtained, and of the facts that certain plants, such as *Spirea* and *Iris* stand out as specially adapted for forcing by this method, whilst others, as for instance many bulbs, are either practically unresponsive to or are too delicate to survive the treatment.

No new plants specially responsive to the treatment were discovered, but the following remarks on two or three of the experiments may be of interest.

Rhubarb.

Last year special attention was called to two points in regard to this plant; firstly, the dipped plants were appreciably *earlier* than those forced in the usual way, and secondly, in addition to bringing about the possibility of this early forcing, it was found, quite unexpectedly, that the method when applied to the plants resulted in a *larger yield.*

Experiment 1.—This was an attempt to test an economical method by which a fairly large number of plants could be "dipped" together, as the small galvanized iron bath previously referred to is inconvenient for large plants like the crowns of rhubarb.

On November 25th, a 50-gallon oak cask was two-thirds filled with water at 100° F. Into this were placed ten two-year-old Rhubarb "Crowns." This caused a loss of heat, but after a few minutes the temperature remained constant at about 95° F.

A lid was now put on the cask, and it was well swathed in wrappers and left till the morning. Between 8.30 p.m. and 7.30 a.m. the temperature of the water had fallen 12° F.

The crowns were now taken out of the water and stored away till the 28th, when they were planted with other rhubarb plants in the ordinary bed of the forcing shed.

The following table shows the amount pulled from these plants, and the dates of pulling :—

Dec. 24th.—	Dipped	plants	7-lbs.	Control	plants	3-lbs.
Jan. 5th.	,,	,,	$3\frac{1}{2}$-lbs.	,,	,,	$4\frac{1}{2}$-lbs.
Jan. 14th	,,	,,	$3\frac{1}{2}$-lbs.	,,	,,	$3\frac{1}{2}$-lbs.
Jan. 28th	,,	,,	3-lbs.	,,	,,	$2\frac{1}{2}$-lbs.
	Total		17-lbs.			$13\frac{1}{2}$-lbs.

Although the dipped plants were both earlier and gave a larger yield than the controls, the result was somewhat disappointing, and this may perhaps be accounted for by: firstly, too great a fall of temperature during the time of dipping (I think that seven or eight degrees is as much as should be permitted), and secondly, by the fact that the crowns were not dried when taken from the cask, but while still damp, were left in a cold place for three days before planting.

The following summary of experiments shows that the plant responds very readily to the dipping method when it is properly applied. In them a large galvanized iron bath, capable of holding six or seven crowns was used. A small gas jet below the bath kept the water at a constant temperature during the whole time of "dipping." The water was first of all heated up to the required temperature and then the crowns were placed in the bath so that they were entirely submerged.

The plants used were two year old crowns which had been lifed in October, and left out of doors so that they had been

exposed to the action of frost, and for one day had actually been covered by snow. After dipping the crowns were planted singly in ordinary soil in a number eight pot, and placed in a dark forcing shed, side by side with pots containing plants treated in exactly the same way except that they had not been dipped.

Experiment 2.—On November 15th five crowns were dipped for twelve hours at a constant temperature of 95° F.

The amounts pulled and the dates of pulling were:—

Dec. 9th.—	Dipped plants 1013 grs ;	Undipped plants 0 grs.
Dec. 19th.	,, 1032 ,,	,, 0 ,,
Dec. 24th.	,, 805 ,,	,, 422 ,,
Jan. 5th.	,, 835 ,,	,, 585 ,,
Jan. 14th.	,, 400 ,,	,, 250 ,,

It will be noticed that the two largest pullings occurred before the control plants had started to yield. The first three pullings were of excellent colour and quality, but those pulled from the dipped plants on the 5th of January were small, and very light in colour, and not fit for market, whereas the controls, which had started much more recently were still of good quality. The pullings from both dipped and undipped plants on the 14th were poor in quality.

The following culture notes apply particularly to this experiment, but are typical of all the others that were made:

December 21st.—Dipped plants had started growth, the buds showing the usual characteristic white appearance. None of the controls showed any sign of growth.

December 24th.—Dipped plants had made a good start, and some of the buds are bursting. Only very few buds are showing on the controls.

December 29th.—Dipped plants with several buds bursting. Some of the sticks three or four inches long. Controls show but little advance, only a few buds showing growth.

Experiment 3.—On November 16th, five crowns were dipped for ten hours at a temperature of 95° F. When planting out, the buds of the dipped plants appeared soft and

slimy. There seemed no reason for this as they had been treated exactly as in the former experiment. The amounts pulled were :—

	Dipped Plants	Undipped plants
Dec. 9th.	807 grs.	0 grs.
Dec. 19th.	801 ,,	806 ,,
Dec. 24th.	770 ,,	806 ,,
Jan. 5th.	445 ,,	1046 ,,
Jan. 14th.	129 ,,	455 ,,

These two experiments show the dipping method results in a very clear gain of about a fortnight, which should be very useful in securing an early market in the case of many kinds of plants.

Experiment 4.—On November 18th five crowns were dipped for eight hours at the same temperature as in the last experiment. Dates and amounts of pulling were :—

	Dipped plants	Undipped plants
Dec. 13th.	1065 grs.	0 grs.
Dec. 24th.	1595 ,,	860 ,,
Jan. 5th.	842 ,,	1165 ,,
Jan. 14th.	508 ,,	457 ,,

Taking the results of all these experiments together there seems no doubt of the effectiveness of dipping regarded simply as a method for early forcing, but it will also be noticed that stimulation resulting in a considerable greater yield has been applied at the same time as appears in the following figures which show the total amounts pulled in each of the experiments.

	Dipped plants	Undipped plants
Experiment 2.	4085 grs.	1257 grs.
,, 3.	2952 ,,	2308 ,,
,, 4.	3990 ,,	2482 ,,
Another experiment	7027 ,,	4485 ,,

These figures, though they emphasize the point under consideration, are somewhat misleading when we come to consider the commercial values of the yield, that is the amount of the yield that is of sufficient quality to be put on the market.

For an indication of this we may consider the yield from the first three pullings in each case. Thus :—

	Dipped plants	Undipped plants
Experiment 2.	2850 grs.	1257 grs.
,, 3.	2378 ,,	2308 ,,
,, 4.	3482 ,,	2482 ,,
Total	8710	6047

Even on this basis, where the allowance for error is a very generous one, it is evident that the gain (over 44 per cent.) is considerable. From observation I should estimate it as being well over 50 per cent. in the majority of cases.

Seakale.

As plants respond to the treatment less readily at the end of their natural resting period than at a somewhat earlier period, it was thought that the failure recorded in the case of seakale dipped on the 13th December might have been due to the dipping having been left till too late.

Two experiments similar to those previously described were carried out at an earlier date. Thus twenty-one crowns were dipped on November 23rd and fourteen on November 26th. In neither case was there any appreciable difference in the yield of the first lot of plants, which were dipped for twelve hours at 31° C. 2-lbs. were cut on December 19th, and 1-lb on the 24th, while the control plants gave 2-lbs. on the 24th and 1-lb. on January 5th. In the case of the second lot, which were dipped for six hours at 35° C. the controls were in every way as good as the dipped plants from the very first.

So that, so far, a difference of about five days is all that the method seems capable of securing.

Bulbs.

Last year the bulbs tried were stated to be, on the whole, unresponsive or to respond in a very uncertain way to the treatment.

The accompanying plate shows results that have since been obtained in the case of hyacinths and narcissus bulbs. A dozen bulbs of each were dipped on December 8th for twelve hours in water at 88° F. They were afterwards planted in pots (four bulbs to a pot) and placed at once in the greenhouse.

In the case of the hyacinths, flowers opened as below :—

Feb.	8th.—4 dipped plants in flower, none of the controls.						
,,	12th.—All	,,	,,	,,	3	,,	,,
,,	19th.				8	,,	,,
,,	23rd.				11	,,	,,
,,	24th.				all	,,	,,

In the case of the Narcissus plants blossoming was as follows :—

Feb.	5th.—2 dipped plants in flower.						
,,	12th.—3	,,	,,	,,			
,,	20th.—5	,,	,,	,,	1 of the controls.		
,,	23rd.—6	,,	,,	,,	2	,,	,,
,,	26th.—10	,,	,,	,,	6	,,	,,
,,	29th.—10	,,	,,	,,	8	,,	,,

My thanks are due to my laboratory assistant, Mr. J. Amos, for the careful help he has given me in these experiments.

Hyacinths.

D.—" Dipped " Plants. C.—Undipped, or Control Plants.

Narcissus.

D.—" Dipped " Plants. C.—Undipped, or Control Plants.

THE GROWING OF TOBACCO FOR NICOTINE EXTRACTION.

Part II.

By G. H. Garrad, N.D.A.

Introduction.

The results of the experiments in Tobacco growing carried out at Wye in the summer of 1910 for the purpose of making a Tobacco Extract for use as an insecticide, and described in a pamphlet issued by the College in April, 1901, were of so encouraging a nature that it was considered advisable to carry the investigation further during the season of 1911. The 1910 experiments had shown that tobacco could be grown in England, that a fairly large crop of 1,500 to 2,000 lbs. dry leaves per acre might reasonably be expected on good soil, and that with a suitable variety this weight of leaf should yield about 70 lbs. nicotine. The expenditure in growing the crop amounted to about £22 per acre, so that the cost of the home-produced nicotine worked out at about 6s. 6d. per lb., plus the cost of extraction, as compared with 15s. per lb. charged for the commercial article.

The second season's experiments were carried out on similar lines to those of the previous year, with the idea of verifying those results and exploiting such theories as suggested themselves after careful perusal of those figures.

The uses and value of nicotine to the fruit and hop grower, as well as to the sheep breeder and feeder, have been described at length in the previous report. It will suffice, therefore, to state here that it is the most effective remedy known for several of the worst insect pests the farmer has to deal with, and if only it could be obtained at a reasonable price it would be used on a large scale by every fruit and hop grower in this country. It stands unrivalled as a cure for the Apple Sucker

and for the Hop Damson Aphis, but at its present price no ordinary farmer can afford to use it. With nicotine (96 per cent. pure) at fifteen shillings per pound, and using it at a strength of ten ounces of nicotine plus three pounds of soft soap per 100 gallons of water—the formula recommended by Prof. Theobald—the wash costs about one penny per gallon as compared with about ¼d. or ⅓d. per gallon for soft soap and quassia. It is true that its killing power is greater and that its effects are more lasting than soft soap and quassia, so that it would be unnecessary to spray so frequently, but even allowing for these advantages the price of nicotine must be reduced by at least half before the fruit grower can be expected to make much use of it.

It was with this idea of getting a cheap tobacco extract of which nicotine should be an ingredient, instead of buying the pure article—a very expensive one to produce—from one of the four nicotine manufactories at work in this country, that these experiments were devised. It was suggested that the fruit grower should grow his own crop of tobacco, that he should choose as heavy yielding and as rank a variety as he could find without any regard to smoking qualities whatsoever, that he should simply dry the leaves when they reached maturity, and not go to the cost of curing or fermenting, and thus get a much cheaper tobacco and one just as suited to his purpose as any he could purchase either in the form of tobacco leaf or of nicotine.

Now if we fix the maximum price which the farmer can afford to pay for nicotine at five shillings per pound, and consider that the cost of growing an acre of tobacco is about £25 to £30, then it follows that from this acre of land the farmer has to produce at least 100 to 120 lbs. of this alkaloid. In the 1910 experiments the best plots yielded at the rate of 80 lbs. nicotine per acre (1,800 lbs. dry tobacco leaves at 4.44 per cent. nicotine), and it was hoped that in 1911, after the experience gained from a year's work with the crop, this figure would be improved on. These hopes were realized, yields at the rate of as much as 200 lbs. nicotine per acre being noted in the case of two small plots, and in several instances yields of 150 lbs. nicotine and upwards were recorded. It must be remembered, however, that the

season of 1911 was a remarkable one, for whereas the previous summer was noted for its coldness and lack of sunshine, 1911 was one of the hottest on record—but these considerations will be fully dealt with later on in their proper place.

Practical Management of the Crop.

The seed of the *Nicotiana Tabacum* varieties was sown in hot frames on March 17th, a week earlier than in the previous season and at the rate of half-a-gram ($\frac{1}{57}$th oz.) of seed per six foot by four feet sash, or one and a half grams per frame of three sashes. The *Nicotiana Rustica* varieties having larger seeds, were sown at the rate of one gram ($\frac{1}{28}$th oz.) of seed per six feet by four feet sash, and being much quicker to germinate, were not sown till a week later. The seed all germinated well. The *Rustica* varieties came up rather too thickly, but most of the *Tabacums* were sown in just about the right quantities. As the plants got larger, a good deal of thinning out became necessary in the case of the *Rustica*, a man spending three whole days thinning out twelve sashes.

One variety, *Erbasanita* No. 4, the seed of which had been to a certain extent acclimatised, being saved from last year's plants, was tried in a cold frame, and germinated freely. The seedlings were planted out in due course and yielded as well as those raised in hot frames in the ordinary way.

On May 10th the tops of the frames were left off at night for the first time, and planting out began on May 23rd, nine days earlier than in 1910.

The land used for the experiments was an adjoining piece of the same field as was used in the previous year. In 1910 it was under potatoes, followed by rape, which was fed off by sheep at the end of January. The land was ploughed in February, and left for the winter. On May 13th it was harrowed and ploughed again, and finally, on May 21st, it was cultivated twice, rolled, harrowed, rolled again, and then marked out for planting with a turnip drill into ridges twenty-five inches apart in both directions.

Artificial manures (3 cwt. Superphosphate and $1\frac{1}{2}$ cwt. Sulphate of Potash per acre) were put on just before planting out, and Nitrate of Soda at the rate of 2 cwt. per acre was applied as a top dressing in two doses on June 14th and

June 28th, after the plants were established. No farm-yard manure was considered necessary as the field had been liberally treated during the two previous seasons.

A belt of Kentucky Hemp was sown round the field on April 20th to afford protection for the wind, but the birds managed to find it out and it had to be resown on May 15th. This necessity for re-sowing made the Hemp very late in coming up, and by the middle of June it was only six inches high. By the end of July, however, it formed a very effective wind break, but in the meantime the field (one acre) was enclosed with hop lewing, which cost £10 17s. 6d. new, exclusive of the poles and the cost of erection.

Planting out began with the *Rustica* varieties on May 23rd, nine days earlier than in 1910, and continued until June 13th. Throughout the whole of this period the weather was very hot and dry, the temperature (maximum) averaging 72° F. over the twenty-three days, but the seedlings were getting too big in the frames to make it advisable to postpone the transplanting. The plants suffered severely from the heat and drought, but were kept alive with the help of water-pots until a good rain fell on June 16th, and when the gaps were filled up on June 23rd it was found that only about four per cent. of the plants had succumbed to the drought.

The transplanting was done in the ordinary way with dibbles, one man raising the plants from the seed-beds whilst others planted them out. It was found that a man could raise 700 plants in an hour, or 9,650 (the number required to plant an acre) in fourteen hours, and another could plant out 140 plants in an hour, or 9,650 in sixty-eight hours. The cost of planting out an acre of tobacco therefore works out thus :—

	£	s.	d.	
Man raising seedlings, 14 hours at 4d.		4	8	
Man planting out, 68 hours at 4d.	£1	2	8	
Cost of planting out	£1	7	4	per acre.

To this has to be added the cost of watering the plants in. A man can water 700 plants in an hour or 9,650 in fourteen hours. A cart-load of water (160 gallons) will suffice for 2,200 plants, so that for an acre of tobacco the water-cart

will have to make 4½ journeys. The cost of watering will consequently be as follows:—

	s.	d.	
Man watering fourteen hours at 4d.	4	8	
4½ water cart journeys at 1s. 0d.	4	6	
Cost of watering	9	2	per acre.

All the plants were watered about three times, on alternate days, for the first week after planting.

As soon as all the plants were established, hoeing commenced (June 15th) and it was repeated at fortnightly intervals until the plants met in the rows. The *Rustica* varieties were the first to go ahead and the first flowers appeared on July 1st. Disbudding ("Suckering") began at the same time and was repeated at intervals of about a fortnight. When no Disbudding had been done for a fortnight it was found that 1,000 plants yielded about forty-two pounds Suckers (Green Weight) these when dried giving only 0.8 per cent Nicotine. They were not therefore considered worth the expense of collecting and drying. The cost of Disbudding amounted to about 12s. 6d. per acre, a man disbudding at the rate of about 250 plants per hour.

The weather all through July and August and up to September 14th was very hot and very dry, the only good rains being a severe thunderstorm on August 20th when there was a fall of an inch of rain within a few hours and a fall of a quarter of an inch on August 25th. Harvesting began with the *Rustica* varieties on August 22nd, eleven days earlier than in 1910, the plants showing signs of premature ripening. The *Tabacum* varieties on the other hand kept their colour for a long time and cutting was delayed until September 20th, eight days later than in 1910. The last plot was cut on October 3rd. The time of harvesting collided as last year with the Hop Picking and there seems little prospect of this difficulty ever being overcome.

Results of the 1911 Experiments.

The experiments of 1911 were laid out on lines very similar in outline to those of 1910 with a few modifications

and additions. About an acre of land was devoted to the tobacco crop, the main experiments being as follows:—

1. To find the effect of soil on the size and nicotine content of the crop.

2. To show the effect of manures on the size and nicotine content of the crop.

3. To find out the best distance apart to put the plants.

4. To find the effect of topping the plants at different heights leaving a varying number of leaves.

5. To discover the best time to cut the plants in order to get the maximum quantity of nicotine.

6. To find the most suitable variety to grow.

7. To discover the best method of drying and harvesting the plants.

8. To test the effect of various denaturants.

9. To discover the most economical method of extraction

Owing to the small size of some of the plots and the consequent small weights of crops obtained from them, there was a good deal of difficulty in getting the exact weights of the dry leaves, and as an error of a quarter of a pound in the case of a plot of fifty plants means an error of something like two hundred pounds when the weights are worked out per acre, it is very important that such weighings should be accurate. Another difficulty experienced was the fact that the leaves have a habit of absorbing and giving off moisture very readily, and a heap of dry leaves which one day weighs twelve pounds may quite easily weigh eleven-and-a-half or twelve-and-a-half pounds a day later, according to the state of the atmosphere. To overcome these difficulties as far as possible the method was adopted of taking the green weight of the leaves as they were picked, and then estimating the dry weight by assuming :—

1. That in the case of the *Rustica* varieties 100 lbs. green leaves are equivalent to 16.36 lbs. dry leaves.

2. That in the case of the *Tabacum* varieties, 100 lbs. green leaves are equivalent to 19.71 lbs. dry leaves.

These standards were fixed after actual experiment with the green and dry weights of something like eighty different samples of tobacco. By using these standards, which may be taken as substantially correct, we overcome the moisture

difficulty, and we also lessen very considerably the effects of inaccurate weighing, an error of half-a-pound in the green weight of a plot being equivalent to an error of only about one ounce in the weight of dry leaves.

The chemical analyses were all carried out by Mr. Longman. They were done by Kissling's method on samples of tobacco which had been thoroughly dried, ground down to a fine powder, and then exposed to the atmosphere in shallow pans to absorb moisture again. The actual results of the experiments, worked out in this way are given in detail in the remainder of this report.

1.—The Effect of Soil.

To show the effect of soil on the Nicotine Content of the crop, experiments were very kindly undertaken by Mr. S. Berry, at Gushmere Court, near Faversham, and Mr. F. Ivo Neame, at Lower Emden Farm, near Chilham, in addition to those carried out at Wye.

The land at Gushmere Court was an old piece of heavy hop garden soil, the hops having been grubbed a year previously. The soil was consequently very rich and no manure was considered necessary.

At Lower Emden Farm a piece of ground was used which had previously grown black currants. The currants had been well treated the two previous years, so here again no farmyard manure was considered necessary.

At Wye the soil selected was a piece of Alluvium last year under potatoes. After the potatoes were off, the land was sown with turnips, which were eaten off by sheep during the winter. This piece of land also had been well done, so no farm-yard manure was applied.

The plants at Wye were placed twenty-five inches apart both ways, but at Gushmere Court, and also at Lower Emden they were planted very much further apart—a great deal too far—and this accounts for the low yields at both those places. At Lower Emden the individual plots were not weighed, but the total yield worked out at the rate of 1,260 lbs. dry leaves per acre, the same as at Gushmere Court. The plots in every case were dried with artificial heat on a hop oast. The weights of crops and nicotine contents are given in Table I.

TABLE I.

YIELD OBTAINED PER ACRE.

	Old Hop Garden (Gushmere Court)			Clay Loam (Lower Emden)		Alluvial Soil (Wye)		
	Dry Leaves.	Nicotine.	Yield of Nicotine.	Dry Leaves.	Nicotine.	Dry Leaves.	Nicotine.	Yield of Nicotine.
	lbs.	Per cent.	lbs.	lbs.	Per cent.	lbs.	Per cent.	lbs.
Rustica ..	1,220	8.10	98.5	Not Estimated.	7.13	2,460	6.57	161.5
Erbasanita ..	990	9.42	93.5		8.16	2,340	6.42	150.0
Blue Pryor ..	1,540	—	—		4.63*	2,310	4.32	99.9
Nykerke ..	1,310	7.19	94.3			1,990	5.83	106.0

* The two samples of Blue Pryor and Nykerke got mixed up and so were analysed together.

Conclusions.—The effect of the soil on the percentage of nicotine in the crop, as illustrated by these experiments, is rather instructive, and bears out the results obtained last year, which showed a very much higher percentage in tobacco grown on rich hop-garden soil, as compared with the same variety grown on other types of land. The lower percentage obtained at Wye may of course be partly accounted for by the fact that the plants were closer together and so got less sunlight. It would be a very interesting experiment to try the effect of growing tobacco on a sewage farm.

2.—The Effect of Manures.

These experiments were a continuation of those of 1910, and carried out on twenty plots, ten plots of *Rustica* (Indian seed), and ten plots of *Blue Pryor* (home-saved seed), with fifty plants in each plot. The *Rustica* variety was planted out on May 23rd and harvested on September 11th, and the *Blue Pryor* was planted out on May 29th and harvested on September 20th. The plants were in every case put out twenty-five inches apart. The results of the experiments are given in Table II.

Conclusions.—In the case of both varieties the plot receiving farm-yard manure in addition to artificials came out the highest in weight of crop, and also in percentage of nicotine, the plot receiving farm-yard manure without artificials coming second. These dunged plots (twenty tons per acre, applied on May 13th) yielded very much better than the green manured plots, a fact possibly due to the green manure, (mustard) sown on March 6th, being ploughed in rather late (May 13th), leaving the land too open for such a dry summer as was experienced. In any case the green manured plots, both with and without artificials, gave some of the worst results in the experiments.

The effect of Nitrate of Soda in increasing the size of the crop was better marked on the plots receiving Kainit than on the plots receiving Nitrate of Soda alone. Taking the Kainit plot, which gave a yield of 100 lbs. nicotine per acre as a starting point, we find that the addition of three cwt. Nitrate of Soda increases the yield of nicotine by 22 lbs., and that when a complete artificial manure mixture is used, consisting of Nitrate of Soda, Superphosphate, and Sulphate of Potash

TABLE II.—THE EFFECT OF MANURES.

(a). RUSTICA (INDIAN SEED).

	Dry Leaves.	Nicotine in Leaf.	Nicotine Per Acre.
	lbs.	Per cent.	lbs.
1½ cwt. Nitrate of Soda	2430	4.61	112.0
3 cwt. ditto	2560	5.10	130.8
4½ cwt. ditto	2500	4.66	116.5
Farm-yard manure	2510	5.50	138.3
Ditto and Artificials	2870	5.61	161.0
Green manure	1560	4.40	68.6
Ditto and Artificials	2290	5.18	118.6
Complete Artificials	2460	4.85	119.3
3 cwt. Kainit	2100	4.59	96.6
3 cwt. Kainit + 3 cwt. Nitrate of Soda	2420	5.25	127.0

(b). BLUE PRYOR. (WYE SEED).

	Dry Leaves.	Nicotine in Leaf.	Nicotine Per Acre.
	lbs.	Per cent.	lbs.
1½ cwt. Nitrate of Soda	2180	5.03	109.7
3 cwt. ditto	2190	5.68	124.1
4½ cwt. ditto	2220	5.68	126.1
Farm-yard manure	2170	5.74	124.8
Ditto and Artificials	2510	5.94	149.1
Green manure	2170	4.89	106.3
Ditto and Artificials	1860	5.38	100.1
Complete Artificials	2200	5.08	112.1
3 cwt. Kainit	2190	4.77	104.4
3 cwt. Kainit + 3 cwt. Nitrate of Soda ..	2470	4.78	118.1

this yield is reduced to 115 lbs. Farm-yard manure by itself gives a yield of about 131 lbs. nicotine, and the addition of artificials increases it to 155 lbs. Nitrate of Soda by itself gives a yield of about 120 lbs., but the addition of large quantities has very little effect. The worst results were obtained on the green manure plots, yielding 87 lbs. nicotine, which was increased to 109 lbs. when artificial manures were added.

3.—The Best Distance Apart.

Six plots, each carrying 120 plants, were devoted to this experiment, three of them being planted with *Rustica* and three with *Blue Pryor*. The seed of both varieties was saved from last year's plants. All the plots received exactly the same treatment with the one exception of the distance apart of the plants. The weights of crop and yields of nicotine are shown in Table III.

Table III.

The Effect of Distance Apart.

	Wgt. of Dry Leaves.	Nicotine in Leaves.	Nicotine per Acre.
(a) *Rustica.*	lbs.	Per cent.	lbs.
Plants 18 in. × 26 in.	3240	6.05	196.1
,, 26 in. × 26 in.	2790	5.86	163.3
,, 36 in. × 26 in.	2480	6.85	170.3
(b) *Blue Pryor.*			
Plants 18 in. × 26 in.	2810	3.78	106.3
,, 26 in. × 26 in.	2440	4.02	98.1
,, 36 in. × 26 in.	2100	4.11	86.3

Conclusions.—The results agree with those of 1910 in showing that the closer the plants are put together the heavier becomes the yield per acre. This is only natural, because the closer the plants the larger the number of them per acre of

ground, but this increase in yield is to a great extent diminished —though not entirely counter-balanced—by a lower nicotine content.

4.—The Best Height of Topping.

Last season's experiments showed conclusively that it was necessary to top the plants in order to get a high yield of nicotine and indicated that it was advisable to remove all but the bottom eight to ten leaves. The experiment was repeated in 1911 in a modified form to test these results.

Four plots of *Erbasanita* (home-saved seed) each containing 120 plants were devoted to the experiment and planted out twenty-five inches apart on May 23rd. They received a complete dressing of artificials but no farm-yard manure, Nitrate of Soda being applied as a top-dressing in two doses of one cwt. each on June 14th and June 28th. The leaves were harvested on September 4th and dried on a hop oast. The results are shown in Table IV.

Table IV.

The Best Height of Topping.

	Dry Leaves.	Nicotine in Leaves.	Nicotine per acre.
	lbs.	Per cent.	Per acre.
Plants topped at 6 leaves	1750	5.64	98.7
Plants topped at 8 leaves	1970	5.32	104.8
Plants topped at 10 leaves	2260	6.06	137.2
Plants topped at 12 leaves	2260	6.62	149.3

Conclusions.—As was to be expected, the plants which were allowed the largest number of leaves gave the heaviest crop, but it was also found that, unlike last year's figures, the plants with the largest number of leaves gave also the highest percentage of nicotine, a surprising result and one not likely to be repeated, unfortunately, in future experiments.

TABLE V.

THE BEST TIME FOR CUTTING.

	Cut Early.	Per cent. Nicotine.	Cut Later.	Per cent. Nicotine.	Increase due to waiting. Per cent. Nicotine.
Erbasanita Height of Topping .. (Average of four Experiments)	Cut August 22nd ..	5.64	Cut September 4th ..	6.18	+ 0.54
Erbasanita Selected Strains .. (Average of eight Experiments)	Cut September 1st ..	5.68	Cut Sept. 12th ..	6.22	+ 0.54
Erbasanita Home Seed ..	Cut Aug. 29th ..	5.64	Cut Sept. 9th ..	6.58	+ 0.94
Rustica Selected Strains .. (Average of eight Experiments)	Cut August 29th ..	6.91	Cut Sept. 7th ..	7.69	+ 0.78
Rustica I Selected Strains .. (Average of six Experiments)	Cut Sept. 6th ..	6.50	Cut Oct. 2nd ..	6.22	— 0.28
	Average ..	6.07		6.58	+ 0.51

5.—The Best time to Cut.

An experiment was carried out in 1910 on a very small scale which seemed to suggest great possibilities in largely increasing the nicotine yield by leaving the plants till they were dead ripe before harvesting, so a number of tests were carried out this season on a larger scale to verify, if possible, this hypothesis. Experiments were carried out on about twenty different varieties, but it will suffice if the results are summarised as shown in Table V.

Conclusions.—The results show that the Nicotine Content increases if the crop is left to stand till it is mature, but if it is left too long, as in the case of the *Rustica* I. Selected varieties which were not cut until October 2nd., there is a slight loss. The high expectations based on last year's figures of increasing the percentage of nicotine by 1.0 per cent or even 1.5 per cent simply by delaying cutting were not verified, but there was a small increase of about 0.5 per cent.

6.—The Most Suitable Variety to Grow.

Thirty four plots, each 50 ft. × 15ft. and containing 168 plants, were given up to a trial of varieties. Five new varieties were supplied by the Slate Seed Company of South Boston, two were sent over by Mr. Keller from Ireland and one by M. Schloesing from France. All the rest were from home-grown seed of the most promising varieties tried last year. The plants were all put out twenty-five inches apart and received a dressing of complete artificials just before planting out but no farm-yard manure. The plots were harvested as they became ready and the leaves dried on a hop oast. The weights of the crops obtained and the percentages of nicotine are shown in Table VI.

Conclusions.—Taking the results as a whole it will be noticed that the standard of excellence reached was a very high one, no less than fourteen plots yielding at the rate of 100 lbs. nicotine or more per acre, the highest yield being 175.6 lbs. nicotine whereas in 1910 the highest yield was only 79.5 lbs. These good results may be explained partly perhaps by the use of acclimatised seed but chiefly by the remarkably hot season.

Table VI.

The Most Suitable Variety.

Variety.	Yield dry leaves.	Nicotine in leaves.	Nicotine per acre.
	lbs.	per cent.	lbs.
Species—Nicotiana Rustica			
Rustica (Ireland, 1909), Selection No. 5.	2480	7.08	175.6
,, ,, ,, No. 4.	2050	8.32	170.7
,, ,, ,, No. 1.	2460	6.57	161.5
,, ,, ,, No. 3.	2380	6.76	160.8
Erbasanita (Italy, 1909) Selection No. 4.	2800	6.06	170.0
,, ,, ,, No. 2.	2560	6.04	154.9
,, ,, ,, No. 3.	2335	6.42	150.0
Rustica (India, 1910)	2520	5.49	138.4
Species—Nicotiana Tabacum :			
Blue Pryor (Wexford, 1910)	2570	5.04	129.7
Yellow Pryor (Ireland, 1909) Selection No. 1	2440	4.55	111.0
Tennesse Red (U.S.A., 1910)	2310	4.68	108.2
Nykerke (France, 1910)	1970	5.50	108.1
Blue Pryor (U.S.A., 1909) Selection No. 4.	2080	5.10	106.5
Blue Pryor (U.S.A., 1909), Selection No. 3	2310	4.32	100.0
Connecticut (U.S.A., 1909), Selection No. 2	2480	4.00	99.2
One Sucker (U.S.A., 1909) Selection No. 1	2210	4.46	98.6
Blue Pryor (King's County, 1910) ..	2260	4.35	98.2
Connecticut (U.S.A., 1909), Selection No. 3	2890	3.32	96.0
Tabacum IV. (India, 1909), Selection No. 1	2100	4.41	92.6
Clardy (U.S.A., 1909), Selection No. 5	2220	3.98	88.3
Warne (U.S.A., 1909), Selection No. 1	2240	3.91	87.8
Lachs (U.S.A., 1910)	1820	4.76	86.6
Little Hill (U.S.A., 1909), Selection No. 5	1700	4.98	84.9
Yellow Mammoth (U.S.A., 1910) ..	1730	4.86	84.3
Tabacum III. (India, 1909), Selection No. 3	1460	5.64	82.6
Clardy (U.S.A., 1910), Selection No. 1	2190	3.69	80.7
Little Hill (U.S.A., 1910), Selection No. 2	1620	4.94	80.0
N. Car. Bright (U.S.A., 1909), Selection No. 2	1720	4.24	72.9
Kentucky Yellow (U.S.A., 1910) ..	1520	4.68	71.3
Yellow Oronoko (U.S.A., 1909), Selection No. 1	1700	4.14	70.2
Big Oronoko (U.S.A., 1910)	1680	3.91	65.8
Tabacum IV. (India, 1909), Selection No. 2	1630	4.02	65.7

Of individuals the most suitable variety for nicotine production seems to be almost undoubtedly some form of *Nicotiana Rustica*, the only varieties of *Nicotiana Tabacum* approaching them being Blue Pryor, Yellow Pryor, Nykerke, and Tennessee Red.

7.—The Best Method of Harvesting and Drying the Plants.

In 1910 the plants were all cut with a chopper at the ground level, tied head downwards on to sticks, and then the sticks hung up in a cowshed to dry at the ordinary temperature of the air. When sufficiently dry, the sticks were taken down and the leaves stripped off the stems and stored away. This was a long process, for even ten weeks after hanging up the leaves were still found to contain thirty to thirty-five per cent. moisture, and there were symptoms of decomposition having taken place.

The nicotine contents in all cases last season were found to be very low, and it was thought probable that if the leaves were dried rapidly by artificial means directly they were harvested, a higher percentage of nicotine would be obtained. The stalks of the plants contain an insufficient quantity of nicotine to justify their being dried and stored, and so it was decided this year in the main experiments to leave the main stems standing in the field, and strip off the leaves, throw them into a cart, and dry them with coal on a hop oast. The cost of harvesting is in that way reduced by about £3 per acre, but there is an extra expenditure of something like £5 per acre in the use of coal for drying, without considering the wear and tear of the oast itself. Mr. E. C. Lister-Kay, of Godmersham Park, very generously gave us the free use of an oast at Ripple Farm for this purpose of tobacco drying, in addition to the College one at Cold Harbour which was only available after the conclusion of hop drying.

Conclusions.—The results of the experiment shown in Table VII. seem to indicate that the extra expense in artificial drying is not justified, the plants dried naturally by the same method as in the previous year giving about 0.5 per cent. more nicotine than those artificially dried. The greater loss in the case of the Blue Pryor plots dried on the oast can be

TABLE VII.

THE BEST METHOD OF DRYING.

(*a*) *Rustica.*

	Kiln Dried.	Air Dried.
	Per cent. Nicotine.	Per cent. Nicotine.
1½ cwt. Nitrate of Soda	4.18	4.66
Farm-yard Manure	5.17	5.45
Green Manure	4.38	4.03
Green Manure + Artificials	5.18	5.18
Complete Artificials	4.42	4.90
3 cwt. Kainit	4.03	4.77
Kainit + Nitrate	4.25	5.87
Average	4.52	4.98

(*b*) *Blue Pryor.*

	Kiln Dried.	Air Dried.
	Per cent. Nicotine.	Per cent. Nicotine.
4½ cwt. Nitrate of Soda	5.51	5.48
Dung + Artificials	4.41	5.94
Green Manure	3.91	4.83
Green Manure + Artificials	4.76	5.30
3 cwt. Kainit	3.80	4.75
Kainit + Nitrate	3.47	4.98
Average	4.31	5.21

explained by the fact that the leaves were dried at an abnormally high temperature—a temperature which at one time was dangerous not only for the tobacco, but for the structure of the oast itself.

The figures are not very uniform, but they certainly seem to indicate that there is no loss of nicotine when the plants are hung up and left to dry gradually in the roof of a shed, or at any rate no greater loss than when the leaves are removed from the plants and dried in the space of a few days with the use of heat.

To test whether there was any loss of nicotine during the period of eight to ten weeks required by these plants to dry, some leaves of Blue Pryor were at cutting time stripped off some plants similar to those harvested on the stalk, strung on to string, and also dried in the roof of a shed. Being detached from the stem of the parent plant these leaves naturally dried very much more quickly, but analysis showed practically no difference between them and the others; see Table VIII.

TABLE VIII.

THE EFFECT OF DRYING THE LEAVES ON THE PLANT.

	Leaves Dried on Strings.	Leaves Dried on Strings.
	Per cent. Nicotine.	Per cent. Nicotine.
Green Manure	4.89	4.83
Green Manure + Artificials	5.40	5.30
Complete Artificials	4.76	4.72
3 cwt. Kainit	5.04	4.75
Kainit + Nitrate	4.95	4.98
Average	5.01	4.92

It seems, therefore, that natural drying, by tying the plants bodily on to sticks, as described in the 1910 report, is the best if there is plenty of room for storing and the dry leaves are not wanted in a hurry. At the same time the leaves will never

get thoroughly dry by this method, and after stripping, it will be found necessary to finish them off with a little artificial heat before they can be safely stored away in a heap without danger of fermentation. It is not easy to dry green tobacco on an oast, because owing to its weight and the amount of water contained in it it is likely to pack and ferment very rapidly unless great care is taken. The leaves of only about 700 plants (one-thirteenth of an acre) can be dried at a time on an ordinary sized oast, and it will take three days at least to dry this amount. If, therefore, artificial drying on hop oasts is to be the method adopted, it will not be possible for any one man to grow a large acreage of tobacco unless he has a considerable number of oasts at his disposal.

8.—The Effect of Denaturants.

This is fully dealt with in Mr. Edwardes-Ker's report, and so need not be considered here.

9.—The Best Method of Extraction.

This is also treated at length by Mr. Edwardes-Ker in his report.

10—The Cost of Growing an Acre of Tobacco.

The figures given in the 1910 report require a certain amount of revision owing to the larger number of plants that it is now considered desirable to grow per acre of ground. The revised figures are as follows :

A.—Cost of Raising 15,000 *Seedling plants.*

	£	s.	d.
Cost of three garden frames (9 sashes) £6. Will last ten years : 12s. per annum. Allow 7s. extra for painting		19	0
9 loads of manure at 5s. per load : 45s. Less 22s. for value afterwards	1	3	0
Watering, ventilating, weeding, thinning out ..		10	0
Cost of seed—¼ ounce at 1s. 8d.			5
Cost of sowing		1	0
Total, say	£2	13	6

B.—Cost of the Crop.

	£	s.	d.
Rent, rates and taxes, ...	2	0	0
Cultivations previous to planting, as for cabbages	1	10	0
Twenty loads farm-yard manure at 5s.	5	0	0
Complete artificial manures	2	10	0
Cost of the seedlings (see above)	2	13	9
Planting out the seedlings	1	10	0
Three waterings of seedlings	1	10	0
Inter-culture—two horse hoeings, three hand hoes	1	0	0
Disbudding: four times at 10s. 6d.	2	2	0
Topping		5	0
Cutting: one man (4d.); two boys (2d.)—200 plants in one hour: 9,650 plants in forty-eight hours	2	8	0
1,000 curing sticks: £2 10s., last three years ..		17	0
3,000 yards binder twine: 20 lbs. at 4d. ..		7	0
Erection of scaffolding		10	0
Carting up to farmstead (½ mile) and storing ..		15	0
Stripping off the leaves	1	15	0
Cost of artificial shelters			
Cost of extracting the nicotine		10	0
Cost per acre	£27	2	6

Returns (1911): 2,500 lbs. tobacco leaves at 6 per cent. nicotine—150 lbs. nicotine. Cost per lb. of nicotine, 3s. 7d.

Remarks:

1.—Allowance has been made for raising fifty per cent. more seedlings than would actually be required so as to make ample room for failures.

2.—Allowance has also been made for three waterings of the young plants after transplanting, which is more than should be necessary in most seasons.

3.—The binder twine would in most cases be obtained for nothing, consisting merely of pieces of ordinary self-binder string which had served the previous season for binding corn and was saved when the corn was threshed.

4.—The cost of artificial wind screens cannot be estimated, as it depends entirely on circumstances, and may even be altogether unnecessary.

5.—The cost of extraction is only a rough estimate for soaking the leaves in cold water. It has not yet been done on a large scale.

6.—A yield at the rate of 150 lbs. nicotine or over was obtained on twenty-three different plots in the 1911 experiments.

II.—The Yield of Nicotine per Acre.

The results of the 1911 experiments show that under the best conditions a yield of as much as 150 to 200 lbs. nicotine per acre can be obtained at a cost of something like £27, so that the cost of the home-grown nicotine works out at about 2s. 3d. to 3s. 6d. per lb or about one-fifth of the price charged by the chemist. This yield of 150 to 200 lbs. is two-and-a half times as great as that obtained in 1910. The reason for so great an increase must be put down very largely to the season, and unfortunately the season of 1911 is not likely to be repeated very frequently.

A comparison of the summer of 1910 with that of 1911 during the period the tobacco was in the ground may be of interest and is given in Table IX., compiled from the Meteorological Records kept at Wye College. Plenty of sunshine has always been considered beneficial to the formation of nicotine, and tobacco, being a tropical or sub-tropical plant, naturally thrives best in a warm summer, but at the same time the crop must have rain, and the yield at Wye would almost certainly have been even better if there had been good rains at the end of May. The ground was very dry at the time of planting out, which began on May 23rd, and it was only by means of watering that the plants were kept alive until June 13th when the first rain fell. Moreover, there was a tendency towards premature ripening about the third week in August, especially in the case of the *Erbasanita* plots, the result of a five weeks' drought and the extraordinarily hot weather ever since the first week of July, which probably had an effect on the crop. Nevertheless, if we consider 1910 an exceptionally unfavourable season for tobacco, we must certainly consider 1911 to have been a particularly favourable one, and consequently must not expect the same high yield of nicotine every year we grow the crop. Exactly how large a crop

TABLE IX.

COMPARISON OF THE SUMMERS OF 1910 AND 1911.

	Average Daily Maximum Temperature.		Rainfall.		Sunshine.	
	1910.	1911.	1910.	1911.	1910.	1911.
	Fahr.	Fahr.	in.	in.	Hours.	Hours.
June	66°	67°	2.45	2.85	141	171
July	65°	83°	2.66	0.28	87	286
August	68°	80°	2.01	1.37	145	245
September	67°	75°	1.19	0.84	124	215

may be expected in an *average* season cannot be estimated until such a season appears.

12.—Plant Breeding.

No difficulty has been experienced in getting plants to mature seed in this country, and the selection of seed plants has now been carried out at Wye for two seasons. Only the very best plants—as considered from yield of leaf coupled with coarseness—have been saved for seed production, and the results of the first season's selections give good ground for hope of our being able to largely increase the nicotine yield of the crop by this method of plant breeding. The selected plants are left untopped and when the flowers begin to show, a truss of them is allowed to remain at the top of the stem, all the rest being removed, and these are enclosed, before they open, in a paper-bag to secure self-fertilisation, and prevent cross-pollination from flowers of other plants. As soon as the seed capsules begin to expand the paper bags are removed and the seed allowed to ripen in the ordinary way. The first lots of ripe seed were collected this year on August 12th.

Seed saved in this way in 1910 was sown in the Spring of 1911. The seed in most cases germinated well, in some cases the germination capacity being as high as 90 per cent., but in a few cases the seed proved to be almost sterile and incapable of germination. The plants of each selection were grown side by side, in rows of twenty-five plants, two rows of each selection, and the results are given in Table X. Seed was again saved from the best plants of each of these selections for future use.

Conclusions.—The results of these selections are very satisfactory, but it must be remembered that fifty plants covering twenty-four square yards of ground are not sufficient for working out yields per acre with any accuracy. Still, the high yields of nicotine characterising the whole of the series as compared with the Variety Plots in Table VII. may be taken as a good guide of improvement of stock having taken place.

13.—General Conclusions.

The general results of the second season's experiments bear out very closely the conclusions arrived at in 1910, and

TABLE X.

SELECTIONS MADE IN 1910.

	Air-Dry Leaves.	Nicotine in leaves	Nicotine per Acre.
(*a*) **Rustica (Ireland, 1909)**	lbs.	per cent.	lbs.
Selection No. 1	2820	8.01	226.3
Selection No. 2	2520	7.69	194.1
Selection No. 4	2590	7.97	206.2
Selection No. 6	2590	7.25	187.6
(*b*) **Rustica (India, 1909)**			
Selection No. 1	2460	5.93	146.0
Selection No. 2	2520	5.82	147.0
Selection No. 3	2430	6.18	150.3
Selection No. 4	2560	6.72	171.8
(*c*) **Erbasanita (Italy, 1909)**			
Selection No. 1	2900	5.98	173.8
Selection No. 2	2620	5.86	153.6
Selection No. 3	2780	5.55	154.2
Selection No. 4	2920	5.67	165.6
Selection No. 5	2650	5.86	155.3
Selection No. 6	2790	5.80	162.0

taking the two seasons together we may summarise the results as follows :—

1. The soil must be of a heavy nature, and rich in plant food and humus. The land must also be well-worked, and an old hop-garden recently grubbed would be suitable *par excellence* for such a crop.

2. The best manure, supposing the soil is not already sufficiently rich, is farm-yard dung combined with a heavy dressing of artificials, containing an excessive quantity of nitrogen.

3. The plants should be put sufficiently close together to cover the ground, 25 inches by 25 inches (9,650 plants per acre), or even closer, being a suitable distance.

4. The plants must be topped fairly low, leaving about twelve good leaves on each plant.

5. All side shoots ("Suckers") must be removed as they form and only plants which are kept for seed should be allowed to flower.

6. The plants should not be cut until they are mature, but at the same time it is unwise to leave them too long.

7. The best and most economical method of harvesting appears to be to cut the whole plants at the ground level, tie them with a string at the base on to sticks, and hang the sticks up in the roof of a dry shed.

8. The most suitable type of tobacco to grow is probably some variety of *Nicotiana Rustica*.

9. The crop is one requiring careful management, especially the raising of the young plants in the hot frames, because weak or spindly seedlings will suffer from their mismanagement at the start all the way through their growth and never yield a satisfactory crop.

10. A yield of 70 to 150 lbs. nicotine per acre according to the season may be expected at a cost of £25 to £30, *i.e.*, 3s. to 8s. 6d. per lb., if the crop is allowed to be grown free of duty, as compared with the market price of 15s. per lb.

The question as to whether we are to be allowed to grow the crop free of duty is still in an unsettled stage. A deputation from the Central Chamber of Agriculture, the National Fruit Growers' Federation and the South-Eastern Agricultural College, waited on the Financial Secretary to the Treasury on May 15th, and put the case clearly before him. Mr. Hobhouse expressed himself entirely in sympathy with the deputation, but stated that tobacco brought in a revenue of something like seventeen millions of money every year, and any action taken by the Board of Inland Revenue must have for its first object the safeguarding of that revenue.

This would be simple enough if the growth of the crop was confined to a few localities and a few individuals, but if indulgences were granted to a number of small growers scattered up and down all over the country it might be exceedingly difficult. He also stated that as the law stands at present no tobacco can be grown duty free in this country, so that new legislation would be required to effect an alteration, and it is not easy for the Government at the present moment to find time for alterations in the law. He also objected that even though it might not be possible to use such tobacco as we should grow for smoking purposes, it would not be difficult for dealers in tobacco to get hold of it and mix it with offal and waste dust, and claim drawback from the Inland Revenue in respect of tobacco which had never paid duty at all. He promised, however, that if regulations could be framed which would protect the Revenue from fraud of any kind without causing any loss to the Exchequer, he would see what could be done to meet the case.

The following proposals were accordingly drawn up and submitted for the consideration of the Treasury.

1. That tobacco be allowed to be grown by responsible persons in quantities of not less than three acres in area of the crop. The number of licences to grow tobacco might be limited for the first year, provided that all fruit-growing districts be given the opportunity of growing experimental crops.

2. That only coarse varieties be allowed to be grown, such as Rustica, Nykerke, Clardy, etc.

3. That the regulations with regard to the growing and harvesting of the crop be the same as those now in force (1911) at Wye College.

4. That within a stated time after harvesting, the crop, either in the green, wilted, or dried state, be denatured with such denaturing materials as the Chief Government Chemist would consider suitable to prevent any illicit use of the leaf or of the extract, care being taken that the denaturants employed do not interfere with the use of the extract as an insecticide for fruit and hop washing or for sheep dipping.

5. That the importation of tobacco extract free of duty be permitted, such extract to be denatured, at the port of entry or in bond, as is suggested in proposal 4.

In reply to these proposals the Treasury refused to agree to proposal 3, saying that a bond would be required and conformation as far as applicable to the regulations proper to the growing of tobacco for smoking purposes. Clauses 1, 2, 4 and 5 were agreed to, provided that a satisfactory denaturant could be found, but the Treasury threw upon the Fruit Growers the onus of finding a satisfactory denaturant.

The denaturants suggested by the College authorities are Sulphur and Sulphate of Copper. Sulphur would ruin the tobacco for smoking purposes, and Copper Sulphate would effectively prevent any extract made from that tobacco being used for illicit purposes. This mixture of Sulphur and Copper Sulphate could be sprayed on to the green plants before cutting or on to the dried leaves, thus denaturing the crop both for smoking purposes and for illicit extraction purposes without in any way affecting its value as an insecticide. The opinion of the Chief Government Chemist on the effectiveness of this mixture is being awaited at the present moment, and negotiations are at a standstill until his report is received.

NOTE ON SMOKING QUALITIES OF THE TOBACCO.

By M. J. R. Dunstan.

The object of these trials was to produce a variety of tobacco which whilst containing a high percentage of nicotine and therefore most suitable for the preparation of insecticidal washes, should be of such a coarse, rank quality as to be unsuitable for smoking purposes, but in order to safeguard the revenue from any attempts at fraud by the illicit use of the tobacco, a satisfactory means of denaturing was also investigated. In order to satisfy ourselves that the tobacco grown was not suitable for smoking, samples of selected leaves of some of the finer varieties which had been more carefully dried than the bulk of the tobacco, were sent to a well-known expert and manufacturer, and his report is appended. This report shows that from the Excise point of view certain varieties are suitable both for smoking and insecticidal purposes, and that if the object of the grower is for the latter purpose, these varieties should possibly be excluded if any remission of duty is to be made. On the other hand it would appear from the report that a shag tobacco of good commercial value may be grown in this country, and it is, therefore, a point for the farmer or market gardener to consider whether the growing of a crop of tobacco will yield a sufficiently tempting rate of profit per acre, provided that the necessary excise regulations do not prove too irksome or difficult for him to observe. Assuming that a crop say of 2,000-lbs. per acre of dried leaf can be grown, and that a sale for this at sixpence per lb. could be secured, a gross return of £50 per acre would be obtained—against this sum an expense of £35 for expenses must be placed, so that there

would seem to be a net profit of £10 to £15 per acre. From reports of the tobacco-growing industry of the world, it seems probable that the demand is overtaking the supply, and there are well-founded rumours of a rise in price next year and probably for the year after also, so that the question of tobacco growing in certain districts in this county is not one entirely outside the range of practical politics.

Report on Samples of Tobacco submitted by Wye College, April 9th, 1912.

" I have carefully examined the four samples of tobacco leaf you sent me. The tobacco was in dry condition, containing, I should say, about 11.5 per cent. of moisture. I did not, however, test it for moisture, so I cannot be quite certain. I had to damp it slightly before I could open it. It was a good brown colour, with a decided tobacco flavour. This flavour would have improved if it had been kept packed in a bale or cask during the coming summer, when a fermentation would have taken place. All tobaccos are greatly improved by this. Your tobacco was similar in appearance to the leaf produced in Kentucky, U.S.A., indeed it would have required an expert to have seen any difference. The 'Blue Prior' was similar to that of the Henderson district, and the other three samples were like the tobacco grown in the Owensboro' district of Kentucky. All of the samples had excellent body, and the leaf was thick. They could all have been used for spinning. The leaf was not large, but was about the size known in the trade as 'Pigtail' Leaf. I had a portion of the 'Blue Prior' and the 'Yellow Prior' stemmed and cut into shag, and a very good looking article was produced. The flavour was much better than I expected, and the burning was good, *i.e.*, complete combustion and white ash. I am afraid a good deal of worse shag is sold in this country at 3½d. per ounce. The tobacco is far better than many of the tobaccos known to the trade as " Cutting Substitutes," and taking into consideration the fact that a rebate of 2d. per lb. is allowed by the Customs on home-grown tobaccos, you would have no difficulty in obtaining 6d. per lb. for tobaccos similar to these samples, and a ready market

could be found for say half a million pounds, or even more. Last season was not ideal for tobacco growing; more rain would have produced a larger leaf and therefore, heavier crop, but whether the quality would have been as good I cannot say.

"I make the following suggestions:—The slight mould on the stalk was caused by the tobacco hanging in a damp shed during the damp weather in October, and this is one of the difficulties of curing tobacco in this country. If some means were found of expelling the damp when the weather becomes moist and after the tobacco has turned brown, it would be a great advantage. If you could remove the stalk the leaf would be worth say 1d. per lb. more. The stripping would cost from ½d. to 1d. per lb.

"In conclusion, I congratulate you on producing an undoubtedly marketable tobacco, and I shall watch your future experiments with great interest."

REPORT ON

ECONOMIC MYCOLOGY.

BY

E. S. SALMON, F.L.S.

CONTENTS.

INTRODUCTORY NOTE.

During the past year a large number of specimens of plants affected with fungous diseases have been sent in by farmers, and also by gardeners belonging to Associations to which lectures have been given by Wye College. A very large number of enquiries on the subject of spraying with fungicides has also been received, particularly with reference to the making and use of the Lime-Sulphur Wash.

Information has been collected with regard to a serious disease which is affecting young Cherry orchards in many parts of Kent. The result of the collection and examination of material from different parts of Kent, and the evidence obtained by visits to orchards at different times in the year, have established the fact that the main, if not the sole, cause of the disease is a particular fungus called *Cytospora*, which has been reported as inflicting damage to Cherry orchards on the Continent. Research into the exact nature of the attack made by this fungus, including also inoculation experiments, have now been started by my assistant, Mr. H. Wormald, with the object of finding, if possible, some remedy. Cherry trees about eight to ten years old are most subject to attack; branches may continue to die annually, or the whole tree may be quickly killed. Any fruit-grower who notices signs of disease in his Cherry orchard is invited to correspond with the College.

The disease known as "Silver Leaf," which is caused by the fungus *Stereum purpureum*, still continues to inflict very considerable losses on growers of Plums, particularly the "Victoria" Plum, in Kent and Surrey, as in other counties. As the result, to some extent, at least, of lectures dealing with the nature of "Silver Leaf," which have been given during

the past four or five years to Farmers' Clubs and Fruit-growers' Associations in Kent and Surrey, fruit-growers in these counties have become alive to the fact that the spread of this disease is due to the general neglect to destroy the trees (or branches) which have died from the disease; for it is on such dead wood that the "fruit-bodies" of the *Stereum* are formed in great quantity and spread the disease.

Until dying and dead "silvered trees" are firmly and systematically dealt with throughout Kent and Surrey we can hardly hope to see this destructive disease become less prevalent.

With the spread of education the time will perhaps come when the farmer who allows dead or dying "silvered" trees to remain in a plantation (where they must inevitably constitute a source of infection for neighbouring plantations of plums) will be classed with the farmer who allows thistles to seed over his own ground and spread to his neighbour's. With the strong Fruit-growers' Associations that are springing up in Kent it should not be difficult for this disease to be effectively dealt with by concerted action—that is, by all growers taking the necessary preventive measures over a large district. One very promising move in the right direction is indicated by the recent application to the College of a Fruit-growers' Association in Kent for advice as to how "Silver Leaf" could be dealt with by *legislative measures.*

In connection with the control of the American Gooseberry Mildew in Kent it is necessary to point out that the present position is decidedly unsatisfactory. Whether the measures decided upon by the Board of Agriculture to combat this new pest are, scientifically considered, wise or not, it is not for us to criticize here. It is obvious, however, that all gooseberry growers should in their own interests co-operate to carry out in a determined manner the measures officially decided upon, so as to give these measures every chance of success, since the Board of Agriculture believes that they are sufficient to save the crop of gooseberries without inflicting too heavy an expense on the grower. The success of the measures depends on the *early autumn* pruning of the diseased bushes; yet we find that on January 9th, 1911, no less than 860 acres out of

the total affected area of 2,536 acres still remained un-pruned.* All through the winter months the "fruit conceptacles" (*perithecia*), containing the *winter spores* of the mildew, continue to drop from the affected shoots and infect the soil; when this has taken place the good that results from the removal of the diseased shoots is to a large extent nullified. In the Board of Agriculture's Report it is stated: "From observations made on affected twigs during the winter months, it seems probable that in most cases of mildew the soil must become heavily infected by the month of February," while in the Report (for the past season) of the Chief Inspector for the Kent County Council, it is mentioned that *an early ripening of the disease, caused by the continuous dry, very hot weather, took place.* Yet, as mentioned above, the early pruning of the affected shoots has not been insisted upon.

At the risk of giving offence, it becomes a duty to point out that "legislative measures" against plant diseases must be in their essence compulsory. These special measures are either worth enforcing systematically and without exception throughout Kent, or they are not; they represent presumably the scientific opinions of the present advisers at the Board on fungous diseases, and the responsibility rests with them.

In the last number of this *Journal* I wrote: "A disquieting feature of the past season is the increased number of attacks of the mildew upon the berries. In 1909 thirteen cases occurred where the berries became mildewed; in 1910 thirty cases occurred." During 1911 no less than 111 cases occurred in which the mildew attacked the berries, and in some instances the loss of the crop was only just prevented.† Plantations in which the pruning of the diseased shoots is not completed until late in the winter must be regarded as a source of danger to all gooseberry-growers in the neighbourhood; it is in such plantations and in their proximity that early outbreaks of mildew on the berries are to be expected.

Considered from the special standpoint of the mycologist, the holding of the first Kent Commercial Fruit Show at Ashford in December last was an event of considerable importance. Economic mycologists in all countries have

* See p. 431.

† See below, p. 428.

always emphasized the point that spraying pays most handsomely when the better fruit that spraying ensures is *marketed* properly, that is, marketed in such a way that the cleanliness of the fruit is displayed. With regard to apples, their cleanliness—particularly their freedom from "scab" (or "black spot")—is best shown when they are packed in boxes, in an attractive "pack," following the best American and Colonial methods.* Boxes of English apples, packed in this up-to-date manner, were exhibited on a large scale at the Ashford Show. As all apple-growers know, there are two reasons why it is absolutely necessary to combat the Apple "scab" fungus,—in the first place, an early attack of "scab," before the apples have grown out, results in a crop of "scabby," one-sided, and often cracked apples of very inferior quality, while a later attack of "scab" which may result in only a few "black spots" or "scabs" on the skin of the fully-grown apples, besides depreciating their quality, is the cause of considerable loss because the storing of such apples becomes impossible, as they will almost certainly "rot."† The point cannot be too much insisted upon that the Apple "scab" fungus has to be completely vanquished, for English apples with even only one or two "scabby" spots on them are damaged in appearance to an extent that they cannot be expected, if boxed, to compete with the absolutely clean boxed apples that come to us from abroad. Taking an *average* season, the practice of boxing English apples must be considered to be bound up with—to absolutely depend upon—the practice of spraying. Unless the majority of our commercial varieties of apples are sprayed regularly to keep off "scab," *the bulk of the crop will not be fit for boxing.*

It must be admitted that, in many seasons, the fight that the apple-grower has to wage against "scab" is not an easy one; to grow a perfectly clean crop of apples fit for boxing necessitates, in the case of many varieties of apples, close attention being paid to many details. It is therefore advisable that when the question of boxing apples is being discussed, the subject of spraying against "scab" should be

* An illustrated Leaflet on "The Packing of Apples in non-returnable wooden boxes" can be obtained on application to the Secretary.

† See this *Journal*, Vol. xvii., p. 309, Plate xiii.

discussed too. At the Show at Ashford last December, the paper given below at p. 408 was read, and an interesting discussion by the Fruit-growers present followed.

Two summer sprays against "scab" can be recommended —Bordeaux Mixture and the Lime-Sulphur Wash (see below, p. 415). *Attacks of "scab" cannot be prevented by winter-washing alone ;* indeed, in most cases, winter-washing against "scab" is quite useless. It is only in those cases where badly-scabbed young wood exists on the trees (see this *Journal*, Vol. xvii, p. 307) that good can be done by winter-washing, and even in these cases winter treatment requires to be followed by summer spraying. Where badly-scabbed young wood exists, as may frequently happen in the case of "Cox's Orange Pippin," "Ecklinville," and a few other varieties,* a spraying in February with the copper-sulphate winter-wash is to be recommended.

With regard to the strength at which it is advisable to use this copper-sulphate wash, I should like to record here the results of some experiments which were carried out early in 1911. Very badly scabbed young shoots of "Cox's Orange Pippin" were treated with solutions of the following chemicals in water, the wash being applied in February with a paint-brush, so that all the scabbed places were thoroughly wetted : caustic soda, 2 per cent. ; copper-sulphate at two strengths, *viz.*, ·4 per cent. and 10 per cent. ; besides these, Bordeaux mixture (4 lbs. copper-sulphate, 4 lbs. quicklime, 50 galls. water) and Lime- Sulphur wash, 1·02 *sp. gr.*, were also used. In April the twigs were finally examined, and the condition of the "scab" fungus on them ascertained. It became apparent by this time that unfortunately the trees that had been used for the experiment were suffering from "canker" as well as "scab," and by this date the "canker" had developed to such an extent that several of both the treated and untreated shoots were dead or dying at the tips. The experiment will be required to be repeated under better conditions, but some results of interest were obtained. The conditions of the shoots under the different treatments were as follows :—*Caustic soda* (seven treated shoots, three con-

* An illustrated leaflet giving the life-history of the "Scab" fungus can be obtained on application to the Secretary.

trols). Both the treated and control shoots were smothered with open, vigorously growing, powdery pustules of the *Fusicladium* stage of the "scab." As expected, caustic soda had no fungicidal effect.

Bordeaux mixture (ten treated shoots, five controls). There was practically no difference between the treated and untreated shoots. The treated shoots bore very numerous—sometimes almost continuous—pustules of *Fusicladium* in an actively growing condition. One application of Bordeaux mixture applied in February appears to have no effect either in killing the pustules of "scab" already present or in preventing further growth of "scab" in the shoots.

Lime-Sulphur wash (nine treated shoots, six controls). Treatment with this wash at 1·02 *sp. gr.* had no apparent effect on the disease, the treated shoots bearing as numerous and as "powdery" pustules of *Fusicladium* as the untreated shoots.

Copper sulphate wash, ·4 per cent. (eight treated shoots, six controls). It was obvious from the first that the Copper sulphate exercised some fungicidal action. The condition of the eight treated shoots in April was as follows :—(1) many "scab" pustules dried up and apparently dead, but here and there living pustules with newly formed spores; (2) fairly numerous pustules with living spores; (3) as in (1); (4) and (5) most of the "scab" pustules dried up, but a few present with living spores; (6) a considerable number of pustules in an actively growing condition,—a few dried up; (7) many pustules dried up, but numerous, apparently freshly-produced pustules full of living spores also present; (8) tip of shoot dead from "canker,"—in the lower living part of the shoot the "scab" pustules were nearly all dried up. All the six "control" shoots bore more or less numerous living "powdery" pustules of "scab."

Copper sulphate, 10 per cent. (four treated shoots, three controls). All the pustules of "scab" on the treated shoots were dried up, and no fresh ones had appeared; on the three "control" shoots the "scab" pustules were numerous and powdery.

The results of the experiments indicated that of the fungicides tried, the copper sulphate wash alone was effective.

Further, there was some evidence that this wash at the strength of 0·4 per cent. (1 lb. copper sulphate to 25 gallons of water)—which is the strength usually advocated—causes only a partial destruction of the "scab" pustules. With the 10 per cent. copper sulphate wash (1 lb. copper sulphate to 1 gallon of water) all the "scab" pustules were killed. Further experiments will be required to ascertain the lowest strength at which the copper sulphate wash is thoroughly effective, as the expense of using a 10 per cent. wash would be too great. Provisionally a 1 per cent. wash (1 lb. copper sulphate to 10 gallons of water) should be tried.

During the past season spraying experiments with the Lime-Sulphur wash were carried out on Apples and also on Gooseberries. The experiments on Apples were planned to ascertain the value of the Lime-Sulphur wash as a spray against "scab" as compared with Bordeaux mixture; and also to find out at what "strength" (specific gravity) the Lime-Sulphur wash can be used with safety on the foliage of different varieties of apples. The dry, sunny, "record" summer of 1911, with the consequent almost total absence of "scab" on apples, prevented the first object of these experiments being attained, but useful information with respect to the second point was obtained.* Details of the experiments carried out are given below.

The spraying experiments on Gooseberry foliage were carried out last summer, under my direction, by Mr. D. Eyre Baxter (then a student studying mycology at this College†) in one of the College fruit plantations The object of these experiments was to ascertain at what strength (specific gravity) this wash can be used with safety on the foliage of gooseberry bushes. The need for a new spray for use against the American Gooseberry-mildew becomes each year more apparent. The legislative measures at present in force are doing nothing in the direction of stamping out this new pest; while the "liver of sulphur" spray, which up to the present is the only known reliable spray to stop the spread of this mildew in its "summer-

* This information is now incorporated in a leaflet on the making and application of the Lime-Sulphur wash, obtainable from the Secretary.

† Mr. Baxter has since been appointed to the post of Assistant Mycologist on a Rubber plantation in Borneo.

stage" has three serious defects,—it is at once removed by rain, it is invisible after application, and it frequently causes on many of the commercial varieties of gooseberries a marked defoliation of the bush. The Lime-Sulphur wash on the other hand is easily seen on the sprayed parts, is remarkably adherent and is not washed off even by heavy rains. The experiments were carried out continuously from May to September, during which time a record was kept of the weather conditions. The experimental results are given below in detail at p.419. Clear evidence was obtained (1) *that different varieties of gooseberries differ as regards susceptibility to injury from the Lime-Sulphur wash*; and (2) *that the amount of injury caused is correlated with certain weather conditions.* Further experimental work on the same lines is necessary before results of practical importance to growers can be obtained. It has been arranged that Mr. C. Wright, a student of this College, who assisted in last year's spraying experiments, shall continue the work on an extended scale during the season of 1912.

In concluding this note I should like to refer to the steady advance in the methods of spraying which is taking place in Kent. During the last six years or so a great advance in knowledge on the subject of sprays and spraying has taken place. Six years ago scarcely a fruit grower in Kent knew the fact that the "apple scab" fungus exists and spreads on the *leaves* of the apple tree, and that the disease can be effectively dealt with by spraying the foliage before it is attacked; Bordeaux mixture was scarcely used at all, and the Lime-Sulphur wash was unknown. At the present time hundreds of apple-growers in Kent and Surrey keep a sharp look-out for the first appearance of the "scab" fungus on the apple foliage, and on its appearance immediately take steps to prevent the spread of the disease. Six years ago the spraying machines on the market were of old patterns, with nozzles suitable for hop-washing but quite unsuitable for throwing the fine "misty" spray required for Bordeaux mixture and for the Lime-Sulphur wash. That is all changed now; English firms at Maidstone and elsewhere who manufacture spraying machinery have applied themselves diligently to the task of inventing new types of spraying machines and nozzles, and it may be said with regard to the methods of spraying

adopted by the progressive fruit growers of this country that they are now in a fair way of beating the Americans at their own game. One of the most interesting immediate questions is,—will the spraying of apples in Kent and other leading fruit-growing counties be continued and extended generally until these counties can rely upon growing regularly, season after season, large clean crops of apples, the bulk of which is fit for boxing ? With regard to Kent at all events, I confidently believe so. On the large fruit-farms, the "power" sprayer—the paraffin-or-petrol-run engine—has just come into use. With such powerful spraying outfits, the work of spraying can be done quickly and at just the right time, a most important point. There only remains then the wise choice of the best spray.

Various "proprietary" washes against fungous diseases are being extensively advertised on the strength of growers' testimonials, stating that trees sprayed with them through the season of 1911 kept free from disease. In any year the majority of such testimonials are liable to be of little value, because as a general rule no "control" trees are left unsprayed. With regard to last season, all such testimonials must certainly be regarded with great suspicion, because owing to the abnormally hot and dry summer *unsprayed* trees, generally, kept free from fungous diseases.* The opportunity may be taken here to point out that when Fruit-growers carefully select adjoining trees as "controls" and keep them unsprayed, and base their opinions of the value of any "proprietary" spray on a study of the differences between these and the sprayed trees, a new era will have commenced. There will then be bad times for the makers of useless sprays, but good times for the makers of the good sprays. It will certainly lead to many hundreds of pounds being saved by Fruit-growers.

As President for 1911 of the British Mycological Society, I delivered an address in September last on the occasion of the meeting of this Society at Taunton. The subject of the address was "Economic Mycology and some of Its Problems." As many of the points touched upon concern the practical grower, the paper is reprinted below at p. 434.

* See below, p. 410.

ON THE USE OF THE LIME-SULPHUR WASH AGAINST APPLE SCAB.

In many seasons, the fight against Apple "Scab" or "Black Spot,"* is not an easy one; to grow a perfectly clean crop of apples necessitates, in the case of many varieties, close attention being paid to many details. Taking average seasons, spraying against "scab" must be reckoned among the regular annual operations in the plantation or orchard.

There are two summer sprays, and only two, which can be recommended for use on a large scale to keep the foliage and fruit of apples clean from "scab," *viz.*, Bordeaux mixture and the Lime-Sulphur wash.

In my opinion, Bordeaux mixture should be used wherever possible, that is, where no injury is likely to result. Bordeaux mixture is to be preferred to Lime-Sulphur for the following reasons: Bordeaux mixture has been thoroughly well-tested and proved to be efficacious in preventing "scab," —it is, indeed, the strongest fungicide we know of; while lime-sulphur is to some extent, in every country, still in the experimental stage, and there is some evidence that it is not strong enough a fungicide to deal with very severe attacks of "scab." Nevertheless, I believe lime-sulphur is likely to prove a valuable spray in certain cases.

With regard to the making and application of Bordeaux mixture, full information has already been given in this *Journal.*† I would advise growers to make their own Bordeaux mixture, the ready-made article is different both chemically and physically from the home-made mixture. Each year more and more fruit-growers are finding that the making of Bordeaux mixture from "stock solutions" of

* An illustrated leaflet, giving the full life-history of the Apple "Scab" fungus, can be obtained on application to the Secretary.

† A leaflet on the subject can be obtained on application to the Secretary.

copper sulphate and "milk of lime" kept near the plantations or orchards is a very simple and inexpensive operation.

Now we come to the important question, what varieties can safely be sprayed with Bordeaux mixture, and at what date should it be applied? As far as my experience has gone, the varieties on which it is safe to use Bordeaux mixture are as follows:—King Pippin, Bismarck, Worcester Pearmain, Allington, Newton Wonder, Cox's Pomona, Jubilee, Warner's King, Wellington, Ecklinville, Quarrenden, Northern Greening, Yellow Ingestre, Pott's Seedling, Sourings. Among these varieties are some which are very liable to have their crop completely ruined by "scab," *e.g.* Cox's Pomona, King Pippin, Ecklinville, Quarrenden, Wellington, Bismarck. The date for the first application of Bordeaux mixture should be such as to catch the leaves when they are just fully expanded,—that is, soon after the fruit is set. No spraying should be done when the tree is in blossom. A second spraying should be given a month later if the weather conditions are such as to favour the spread of "scab." *In cases where trees have borne a "scabby" crop in the previous season,* I should advise for those varieties which show some leaves before the flowers open, a special, *early* spraying at this time with Bordeaux mixture, to prevent those leaves from becoming infected with "scab" and so starting the disease for the season.

We have now to consider the case of those varieties whose fruit or foliage is liable to be injured by the application of Bordeaux mixture. On the following varieties Bordeaux mixture should *not* be used: Cox's Orange Pippin, Duchess's Favourite, Beauty of Bath, Gladstone, Miller's Seedling, Lady Sudeley. On these varieties the lime-sulphur wash should be used.

The lime-sulphur wash is made in concentrated form by boiling for one hour together definite quantities of lime and sulphur. At the end of this article full information is given as to the process. But I should advise growers—unless they intend to use a very large quantity—to purchase the wash ready-made, in a concentrated form; because with regard to the lime-sulphur wash, unlike the case of Bordeaux mixture, they can obtain on the market from firms of repute exactly

the same wash as the home-made article. If growers boil up the lime-sulphur wash themselves, coupled with the fact that it is a somewhat lengthy and troublesome operation, there is the disadvantage that the concentrated wash obtained is liable to vary considerably in strength, and is always weaker than the factory-boiled article. During the last summer, in different parts of Kent, I boiled up this wash, in various sized coppers under different conditions and using lime obtained from several different kilns in the county. The method adopted of mixing, etc., was exactly the same in every case, yet the concentrate obtained was of very different strengths, varying from as low as 1·12 sp. gr. to 1·23 sp. gr. In the case of the former one gallon of concentrate would make only twelve gallons of the lime-sulphur wash of the right specific gravity (1·01) for usual summer spraying, while in the latter case it would make twenty-three gallons. Such differences are due chiefly to chemical differences in the lime, but also to differences in the manner of boiling, due to the fire and kind of copper. Firms of repute are now putting on the market in this country—as firms have been doing in America for several years past—a factory-boiled concentrated lime-sulphur wash of definite specific gravity; such a concentrated wash can be obtained of the sp. gr. 1·30; one gallon of this will make thirty gallons of the summer wash of sp. gr. 1·01. Buyers of factory-made lime-sulphur washes should obtain a guarantee as to their uniform specific gravity, or a guarantee that a stated number of dilutions will result in a wash having the sp. gr. 1·01. To use lime-sulphur washes of unknown strength is, if not to court disaster, at least not to reach any definite knowledge.

With regard to the work carried out last year with the home-boiled lime-sulphur wash, experiments were made at six centres, through the co-operation of the following growers:—Mr. W. W. Berry, at Selling, Mr. G. Champion, at Linton, Mr. F. I. Neame, at Chilham, Mr. E. I. Overy, at Paddock Wood, Mr. J. A. Raynham, at Marden, and Mr. A. J. Thomas, at Rodmersham. These experiments were devised to test the relative efficiency against "scab" of Bordeaux mixture and lime-sulphur wash at different strengths. The main object of these experiments was defeated by the dry, sunny,

"record" summer; all the sprayed trees grew a splendid crop of clean well-grown apples,—but so did all the unsprayed, check trees! In one case only did "scab" appear to any appreciable extent. In Mr. Neame's plantations evidence was obtained that the lime-sulphur wash (sp. gr. 1·01) controlled a mild attack of scab on Worcesters and Bismarcks, since here the "check" trees sprayed with a proprietary wash showed decidedly more of the fungus.

Our series of experiments served, however, to show at what concentration lime-sulphur is safe to use. During the past season the wash at "full strength" (1·01) was used on the following varieties:—Worcester, King Pippin, Bismarck, Beauty of Bath, Newton Wonder, Gladstone, Lady Sudeley, Ecklinville, Miller's Seedling, Warner's King, Duchess' Favourite. The spraying was done in May and June, and no scorching of the foliage or injury to the fruit resulted, except in two cases; once on Worcesters, where the leaves were burnt at their edges, although no leaf-fall was caused; and in the second case on some twenty-year-old trees of Wellington and Ecklinville, where the leaves became "scorched" at their edges and spotted over with red marks, resulting in a slight leaf-fall. The wash at "half-strength" (sp. gr. 1·005) proved harmless on Wellington, Cox's Orange Pippin, Stone's Seedling, Chelmsford Wonder, Hunt's Early, and Hector Macdonald. On Smart's Prince Arthur lime-sulphur at full-strength produced serious "scorching," resulting in a marked leaf-fall; there was serious injury too, on this variety, with the wash at "half-strength,"—very possibly, however, the trees had been too heavily sprayed. It may be noted, however, that similarly-sprayed trees of Chelmsford Wonder showed very little "scorching," and trees of Newton Wonder, quite as heavily sprayed, no injury at all. The "quarter-strength" wash (sp. gr. 1·0025) was used in some cases, but it proved unsatisfactory, being so weak that it soon disappeared. I should advise growers not to use a weaker spray than sp. gr. 1·005. One valuable fact emerges from the experiments of the past two seasons, viz., that it is apparently quite safe to spray the foliage and fruit of Cox's Orange Pippin with lime-sulphur at the strength sp. gr. 1·005, even when two applications are made; it is a great thing to have found a safe spray

for this tender variety. I would strongly advise growers not to use on apple foliage a lime-sulphur wash stronger than sp. gr. 1·01, as there are indications that at this strength we are near the danger zone. I believe it is quite safe to use it at this strength in May or early in June on most varieties of apples; it will probably be found that later in the season, when the leaves become punctured by insects and damaged by fungi, this wash will cause some amount of "scorching" and leaf-fall.* In all cases of doubt a few trees should be sprayed experimentally, since with lime-sulphur (unlike Bordeaux mixture) whatever injury is going to be caused appears soon after spraying—within a week at the longest.

Evidence collected in the States shows that unless care is taken, there is considerable danger of injury due to "scorching" being caused to apple foliage by the use of the lime-sulphur wash. The causes of "scorching" are (1) use of the wash at too strong a concentration; (2) the drenching of the foliage, instead of lightly spraying it; (3) the presence of previous injury on the leaves. Such injury may be due to the action of insects or to the attacks of fungi. An important fact to remember is that if trees are *heavily* sprayed with a lime-sulphur wash at a comparatively low concentration, more "scorching" may result than if they were lightly sprayed with the wash at a considerably higher concentration.

Quite recently certain facts, possibly of considerable importance, have been discovered by experimenters in the United States, in connection with the lime-sulphur wash. Evidence gathered from a number of experiments seems to show that arsenate of lead alone possesses some *fungicidal* property, although this is weak; what is more important, there is stronger evidence that lime-sulphur to which arsenate of lead has been added, has considerably greater fungicidal properties than lime-sulphur alone. Arsenate of lead and lime-sulphur, when mixed together undergo a chemical change; the combined spray is still as effective against caterpillars as the arsenate of lead alone, while it is decidedly more effective (perhaps double as effective) as a fungicide

* Some trees of "Lane's" and 'Stirling Castle" in the College plantation sprayed on June 19th with the Lime-Sulphur wash at 1·01 sp. gr. were appreciably "scorched," and a marked leaf-fall resulted.

than the lime-sulphur alone. The figures in one case were as follows—lime sulphur alone reduced " scab " on Greenings from 79 per cent. to 29 per cent ; lime-sulphur plus arsenate of lead (2-lbs. to the fifty gallons) reduced the " scab " to 10 per cent. On pears, lime-sulphur alone reduced " scab " from 100 per cent. to 74·2 per cent ; lime-sulphur plus arsenate of lead (as above) reduced the " scab " to 8·5 per cent. We have yet to find out whether these results will hold good under the different conditions in this country ; but I would advise growers always to use arsenate of lead mixed with the lime-sulphur if there is any fear of caterpillars, and where there is not, to use lime-sulphur plus arsenate of lead on a few rows of trees, and compare the effect with that of lime-sulphur alone.

The general instructions for dealing with Apple Scab are as follows :—spray the leaves as soon as they have well expanded with Bordeaux mixture if there is no fear of injuring them or " russeting " the fruit ; if there is this danger, then use the lime-sulphur wash at " full strength " (sp. gr. 1·01), or at " half-strength " (sp. gr. 1·005), according to the variety and time of year. Use arsenate of lead (preferably in the form of Swift's " Arsenate of Lead Paste ") mixed with the lime-sulphur *experimentally*. Remember that it is often the first leaves which come out in the spring round the blossom-spurs that become " scab "-infested and a source of infection for the leaves that appear later. I think that an early spraying of Bordeaux mixture on the first, just-expanded leaves (no harm will be done at that time of the year to any variety of apple) followed by a later spraying of lime-sulphur will prove to be the best treatment for many of the more delicate varieties of apples. Remember that both Bordeaux mixture and the lime-sulphur solution must be applied in a fine, " misty " spray.

One practical point of considerable importance must be borne in mind. Both with Bordeaux mixture and with the lime-sulphur wash, *spraying should be done before the " scab " has appeared on the leaves*. If either spray is put on leaves which are already " scabby," *the parts of the leaf where the " scab " fungus exists are killed* (*together with the fungus*), or the whole leaf may curl up more or less, or even drop off.

This kind of injury, which is, of course, very noticeable, is due entirely to the death of the portions of the leaf already infested by the "scab" fungus, and it must not be confused with *spray injury proper*, which is liable to occur on perfectly healthy leaves when certain washes are used.

Spraying experiments were also carried out with two modifications of the "self-boiled" lime-sulphur wash, made as follows. The *iron-sulphide* wash: place 8-lbs. quicklime in a fifty gallon barrel, and pour two or three gallons of boiling-water over it. Stir 8-lbs. of "flowers of sulphur" (running the sulphur through a fine sieve in order to break up any lumps) into the slaking lime, and add another bucket of hot water. Stir occasionally in order to prevent caking. Cover over the barrel with sacking so as to retain the heat given out by the slaking lime, which will cause the mixture to boil for ten to twenty minutes—according to the quality of the lime. During this boiling a small amount of the sulphur goes into solution. As soon as the lime has slaked—that is, as soon as the boiling has ceased—add cold water up to the forty-gallon mark, in order to prevent more sulphur going into solution. The mixture should be strained through a sieve of twenty meshes to the inch, in order to remove the coarse particles of lime, but all the sulphur should be worked through the strainer. Then add ten gallons of water in which 3-lbs. of iron sulphate have been dissolved. The mixture which, on being stirred, turns inky black; on drying on the tree, it turns a dark slate colour. In a few days, this oxidises to a reddish-brown colour, which remains constant.

The *copper-sulphide* wash is made as above, except that 2-lbs. of copper sulphate dissolved in ten gallons of water are added to the "self-boiled" lime-sulphur mixture.

The iron-sulphide spray was applied on June 7th to a row of "Warner's King," on which "scab" was beginning to appear. The trees were heavily sprayed with a fine "misty" spray, and when the spray was dry the trees were uniformly covered over with a mud-coloured deposit. This spray proved extraordinarily adherent. On June 20th, by which time several heavy rain-showers had fallen, the spray showed no signs of having been washed off at all.

No injury was caused by this spray to either the foliage or to the apples. The " scab " that had been present on the leaves of the sprayed trees was killed, and no further infection took place on them, while for a little time the " scab " continued to increase on the leaves of the " control " unsprayed trees. Later in the season, however, the " scab " died away completely on all the " control " unsprayed trees. The results of the experiment showed that this Iron-Sulphide wash has some fungicidal powers, though whether it will prove efficacious in stopping continuous and severe attacks of " scab " has yet to be ascertained.

The copper-sulphide wash was tried on adjoining trees of the same variety, and showed the same amount of promise. Both washes are as yet only in the early stages of experimentation ; it is intended to use them again in next season's spraying experiments.

Trial was also made of a *precipitated sulphur* wash. A certain quantity of the copper-boiled lime-sulphur wash was taken, and its sulphur precipitated by the use of sulphuric acid. This precipitated sulphur, which is in the form of a whitish amorphous paste, was sprayed on the foliage of Cox's Orange Pippin. Though the sprayed foliage was not, in the early part of the season, kept entirely free from " scab," the disease was decidedly kept down as compared with adjoining " control " trees of the same variety. As " Cox's " is so difficult a tree to spray without causing some injury to the leaves, it is possible that this " precipitated sulphur " wash—which is entirely harmless to foliage—may prove of some value on certain occasions. It will be used in next season's trials.

Instructions for making the Lime-Sulphur Wash.

This wash is prepared by boiling lime and sulphur with water. A chemical reaction takes place, bringing about the solution of the lime and sulphur.

The wash is most conveniently prepared in a concentrated form and afterwards diluted.

Recent chemical investigations have shown that the following formula is the best :—

Quicklime (in lumps)*	.. ..	48-lbs.
Flowers of Sulphur †	.. ..	96-lbs.
Water	.. ..	50 gallons.

Some form of heating apparatus is necessary, such as a "copper." Iron or zinc are suitable, *but copper ones must not be used.*

Prepare the wash as follows :—

Put 10 gallons of water in the "copper" and start the fire. Add the 48-lbs. of quicklime. When the slaking is well started, add the 96-lbs. of sulphur gradually, and mix until a thin even paste is formed, taking care to break up all the lumps of sulphur as far as possible. If too thick, a little more water can be added. When thoroughly mixed add water up to the 50-gallon mark (using a measuring stick), *boil vigorously for one hour,* stirring frequently and adding water when necessary to keep it at the same level.

The wash thus prepared (on settling) will be a clear orange-red liquid, consisting of a solution of sulphides and poly-sulphides of calcium, together with small amounts of other sulphur compounds. There will also be a small amount of insoluble lime and sulphur.

Lime-sulphur washes vary in chemical properties according to the proportions of lime and sulphur used, the method of mixing and the length of time of boiling. If the above instructions are carried out accurately the resulting wash will contain the maximum amount possible of the most valuable chemical constituents.

Strain through a fine brass or galvanized-iron strainer, and store at once where air cannot reach the liquid. This concentrated wash can be kept until wanted for use, stored in stone jars or in barrels. If in open barrels, the surface of the fluid must be protected from the air by a layer of oil (mineral).

The concentrated wash requires to be diluted with water before being used on foliage. It is necessary to ascertain its

* Good fresh quicklime (containing not less than 90 per cent. calcium oxide) should be obtained, as otherwise the concentrate will not be of the desired density.

† If any lumps are present, pass the sulphur through a fine sieve before use.

specific gravity, for which purpose a *hydrometer** is necessary. The specific gravity of the concentrate will vary considerably, due chiefly to differences in the lime used, and also to details connected with the manner of boiling. A good home-made concentrated lime-sulphur wash will have a specific gravity of about 1·20.†

The concentrated wash requires to be diluted with water until it has a specific gravity of 1·01, when the wash may be termed "full-strength"; or further diluted until it has a specific gravity of 1·005, for the "half-strength" wash. One gallon of the concentrated wash at 1·20 specific gravity will make 20 gallons of the "full-strength" wash (1·01 sp. gr.), or 40 gallons of the "half-strength" wash (1·005 sp. gr.).

Firms of repute are now placing on the market a factory-boiled concentrated lime-sulphur wash of higher specific gravity, *viz.* 1·300, than can be obtained in home-made preparations. One gallon of such a wash will make 30 gallons of the "full-strength" wash (1·01 sp. gr.), or 60 gallons of the "half-strength" wash (1·005 sp. gr.). Unless a very large amount of the present wash is used—which is not advisable at present, as the lime-sulphur wash is still largely in the experimental stage—it is probably more economical for the grower to purchase one of the ready-made concentrated lime-sulphur washes than to boil up the mixture himself.

In America some success has attended the use of the present wash as a fungicide against "black spot" or "scab," for use on those varieties of apples which are liable to be "scorched" by Bordeaux mixture. It must be remembered, however, that the lime-sulphur wash as a summer spray is still only in the experimental stage. Bordeaux mixture still remains the best wash for general use against "scab" on apples and pears. Growers, before using the lime-sulphur wash on any considerable acreage, should observe its effects on a few trees. The ill-effects (if any) would be of the nature of "scorching" the leaves, and would be apparent three or four days after

* Hydrometers with a specially prepared scale can be obtained, with full instructions for use, of Messrs. Baird & Tatlock, 14, Cross Street, Hatton Garden, London, at 3s. 6d. each.

† Samples of the concentrated wash (which may be put in a small medicine bottle) sent to Wye College by any grower in Kent or Surrey will be determined for density free of charge.

spraying. The wash should be applied with a nozzle throwing a very fine " misty " spray. After application to the leaves, the atmosphere acts on the wash, causing the deposition of sulphur. This sulphur is in an excessively fine state of division, and adheres so intimately to the surface of the leaves (in the form of a whitish, scarcely visible powder) *that rain will not wash it off*.

The receptacle used in spraying must be wooden or iron (galvanised iron or tinned) ; *a copper knapsack must not be used* as the dissolved sulphur acts on this metal. The " Eclair étame " knapsack sprayer (made by Vermorel), which is tinned over, is suitable, and gives an efficient spray.

SPRAYING EXPERIMENTS WITH THE LIME-SULPHUR WASH ON GOOSEBERRIES.

By D. Eyre Baxter and E. S. Salmon.

The object of the experiment was to ascertain at what strength (specific gravity) the Lime-Sulphur Wash can be used on the foliage of the Gooseberry from May to September without causing injury.

The Gooseberry bushes used were growing in one of the fruit plantations at Wye College. The Lime-Sulphur Wash was made on the formula given in this *Journal*, Vol. XIX., p. 347, and was used at the following strengths :—

(1) specific gravity 1·005
(2) specific gravity 1·0025
(3) specific gravity 1·001

The first variety of Gooseberry sprayed was Whinham's Industry, the variety which has the next largest acreage in North Kent to Lancashire Lad. Three bushes were sprayed with the wash at each of the above indicated strengths, making nine bushes at each spraying. The spraying was done approximately every fortnight, from the end of May to the beginning of September, using fresh bushes for each spraying. Each bush was thoroughly sprayed, using the Vermorel "Eclair Etamé" Knapsack Sprayer; three-quarters of a gallon of the wash was used on the three bushes, which were four years old. The bushes were closely observed each day after they had been sprayed, for about a fortnight with the object of noting what leaf-fall, if any, occurred, and at what date. A daily record of the general weather conditions was kept to ascertain if there was any connection between these and the susceptibility of the foliage to injury.

In the case of Whinham's Industry there was no leaf-fall throughout the whole experiment extending from May to September, notwithstanding the exceptional amount of

brilliant sunshine and the abnormally high temperatures that occurred during the past summer.

(When the non-susceptibility to injury of "Whinham's Industry" became apparent, a series of sprayings was started with the Lime-Sulphur wash at a higher concentration, *viz.*, 1·01 sp. gr. Three bushes were sprayed on July 21st, Aug. 21st, and Sept. 5th,—fresh bushes being used on each occasion. There was a very slight leaf-fall from the bushes sprayed on Aug. 21st, but not enough to cause any appreciable injury. There was no leaf-fall from the bushes sprayed at the other two dates.)

Exactly the same treatment as that described above in the main set of experiments with Whinham's Industry, was given during the same period to an equal number of bushes (four years old) of Berry's Early,—the variety which in North Kent comes next in importance to Whinham's Industry. Very different results were obtained. On this variety, *under certain weather conditions*, serious injury occurred resulting in a severe defoliation of the shoots of the bushes. The results obtained are tabulated below. The leaf-fall was ascertained by actual counting of the fallen leaves (see Table p. 421).

If we take this Table, and average the percentages of the leaves that fell from the three bushes at each spraying, we obtain an estimate of the amount of injury liable to be caused to "Berry's Early" by the Lime-Sulphur Wash (see Table p. 422).

With the wash at 1·005 sp. gr. serious injury occurred in three instances, *viz.*, in Experiments 1, 5 and 7. If, as would probably be the case, more than one spraying would be required to protect the bushes from mildew, such injury as this might be serious enough to preclude the use of the wash. (It is to be noted that in some instances the wash at a lower concentration caused more leaf-fall than at a higher concentration, *e.g.*, in Experiment No. 1, the wash at 1·001 sp. gr. caused 17·1 per cent. of the leaves of the shoots to fall, while the wash at 1·0025 sp. gr. caused 12·4 per cent. of the leaves to fall.)

On the other hand, in three cases, in Experiments Nos. 2, 3 and 6, the injury was much less severe, not severe

Comparison of Leaf-fall on "Berry's Early" Sprayed with Lime-sulphur Wash.

Bush No.	(1). 1.005 sp. gr. Leaf-fall commenced.	Period of fall.	Percentage of leaves fallen from shoots.	(2). 1.0025 sp. gr. Leaf-fall commenced.	Period of fall.	Percentage of leaves fallen from shoots.	(3). 1.001 sp. gr. Leaf-fall commenced.	Period of fall.	Percentage of leaves fallen from shoots.	Sprayed.	Weather conditions.
		days.			days.			days.			
1	June 2	8	25.6	June 2	8	12.8	June 2	10	15.1	May 26	May 26—June 8. Scorching sun with breeze; some rain on June 3.
2	,, 2	8	15.3	,, 2	8	5.2	,, 2	8	21.2	,, 26	
3	,, 2	8	26.5	,, 2	10	19.2	,, 2	8	14.9	,, 26	
1	,, 17	11	3.5	,, 17	11	2.9	,, 17	11	2.1	June 9	June 9—20. Chiefly cool, cloudy, and rainy; very little sunshine.
2	,, 17	11	6.3	,, 17	11	4.6	,, 17	11	2.3	,, 9	
3	,, 17	11	1.7	,, 17	11	3.3	,, 17	11	2.5	,, 9	
1	,, 27	1	0.2	,, 27	1	0.6	,, 28	3	1.7	,, 21	June 21—July 1. Cool, with rain, then warmer, but cloudy.
2	,, 29	2	1.9	,, 27	4	1.4	,, 27	4	2.0	,, 21	
3	,, 27	1	0.3	,, 27	4	2.1	,, 27	2	0.6	,, 21	July 2—7. Scorching sun.
1	July 9	9	4.1	July 9	9	6.0	July 9	—	0.0	July 7	July 7—20. Very hot most of time, with breeze. Shower of rain on July 15.
2	,, 9	9	5.0	,, 9	9	6.1	,, 9	9	5.1	,, 7	
3	,, 9	9	6.6	,, 9	8	7.4	,, 9	6	3.5	,, 7	
1	,, 24	12	13.6	,, 24	12	13.1	,, 24	12	10.9	,, 21	July 21 and 22. Scorching sun.
2	,, 24	12	12.9	,, 24	12	8.2	,, 24	12	7.1	,, 21	July 23—26. Cool; rain.
3	,, 24	12	21.5	,, 24	12	8.4	,, 24	12	5.4	,, 21	July 27—Aug. 4. Scorching sun.
1	Aug. 26	1	1.0	Aug. 31	8	1.5	Sept. 2	6	1.8	Aug. 21	Aug. 20. Severe thunderstorm.
2	,, 26	12	8.6	,, 26	12	3.1	,, 2	6	1.4	,, 21	Aug. 21. Rain; dull, subsequently dull and warm. Hot on Sept. 6 and 7.
3	Sept. 1	7	1.6	,, 26	12	3.4	Aug. 26	12	2.3	,, 21	
1	,, 8	5	19.6	Sept. 8	5	10.3	Sept. 8	5	8.5	Sept. 5	Sept. 5. Warm; bright.
2	,, 8	5	14.2	,, 8	5	8.5	,, 8	5	7.5	,, 5	Sept. 6—8. Scorching sun.
3	,, 8	5	14.0	,, 8	5	10.0	,, 8	5	7.8	,, 5	Sept 9. Cool; cloudy. Sept. 10 and 11. Hot. Sept. 12 and 13. Cooler; dull.

Average total leaf-fall from the shoots of the sprayed bushes.

Experiment.	1·005 sp. gr.	1·0025 sp. gr.	1·001 sp. gr.
	Per cent.	Per cent.	Per cent.
No. 1	22·5	12·4	17·1
,, 2	3·8	3·6	2·3
,, 3	·8	1·4	1·4
,, 4	5·2	6·5	2·9
,, 5	16·0	9·9	7·8
,, 6	3·7	2·7	1·8
,, 7	15·9	9·6	7·9

enough to prevent the use of the Lime-Sulphur Wash if it were proved that the wash at the strength used is an effective fungicide.

Now if we compare the weather conditions that obtained at the time of the three sprayings in Experiments Nos. 1, 5 and 7, with those that obtained at the time of the three sprayings in Nos. 2, 3 and 6, we obtain evidence that seems to indicate that *the amount of injury inflicted is dependent upon certain weather conditions.* In the three instances where serious injury was caused, the weather conditions at the time of spraying and soon afterwards, were as follows :—Nos. 1 and 5, " scorching sun " ; No. 7, " warm and bright " to " scorching sun." In the three instances where little injury was caused, the weather conditions were as follows :—No. 2, " chiefly cool, cloudy and rainy " ; No. 3, " cool, then warmer, but cloudy " ; No. 6, " rainy and dull."

The results generally would seem to indicate that it is not safe in very hot sunny weather to use the Lime-Sulphur Wash even at " half strength " (sp. gr. 1·005), or indeed at the lower concentrations, on such varieties as " Berry's Early." " Yellow Rough " may be expected to show a similar susceptibility. The susceptibility shown holds good as regards both the young foliage in May and the old leaves in September.

On the other hand, in cool or cloudy weather—such as we usually have in this country at the time of the year when the mildew is first beginning to spread for the season by means of the spores formed in the "summer stage," the Lime-Sulphur Wash, diluted to 1·005 sp. gr. may safely be used on such varieties as "Berry's Early."

The results of a separate experiment showed the same association of a marked leaf-fall with very hot weather. In this experiment three bushes of "Berry's Early" were sprayed with the 1·005 sp. gr. wash on July 3rd; three fresh bushes were similarly sprayed on July 9th. The weather conditions at the respective dates were as follows:—July 3rd to July 8th, "scorching sun, with strong breeze"; July 9th to July 14th, "cloudy." The average total leaf-fall that resulted on the bushes on the two occasions was as follows:—July 3rd, 19 per cent., July 9th, 5·2 per cent.

A few experiments were carried out with the object of seeing what effect, if any, *shading* the bushes would have. On July 3rd, three bushes of "Berry's Early" were shaded by means of matting held over them by poles. This was done overnight, so that the bushes should not be exposed to the direct rays of the sun until the spraying had been done. The spraying was carried out during the morning of the next day, July 4th, and the shading was removed as soon as the wash had dried on the leaves. The strength of the wash used was 1·005 sp. gr. On the same morning, three bushes of the same variety, which had not been shaded previously, were similarly sprayed, and then as soon as the spray had dried were shaded. As controls, three bushes were sprayed under natural conditions in the open. The weather conditions at the time were as follows:—July 4th to July 8th, "scorching sun." The same experiment was attempted on July 10th, but unfavourable conditions for the experiment supervened. The weather conditions on July 10th (when the actual spraying was done) being "cloudy" (*i.e.*, with *occasional* sunshine), "with breeze."

The results obtained are shown in Table on p. 424.

In the first spraying on July 4th, the average total leaf-fall on bushes shaded until the spray had dried, was 32 per cent., as against 16·9 per cent. on the bushes sprayed in sunshine

Method of treatment of bushes.	Sprayed July 4. Percentage of leaves fallen from shoots.			Sprayed July 10. Percentage of leaves fallen from shoots.		
	1	2	3	1	2	3
Shaded overnight and through the next day until sprayed; exposed after spray had dried ..	23.2	43.7	29.2	2.5	1.5	4.6
Sprayed in sun and shaded as soon as the spray was dry ..	17.7	17.5	15.4	5.6	4.5	6.6
Sprayed in sun and left exposed	11.3	18.9	25.9	4.1	5.0	6.6

and shaded as soon as the spray was dry, and 18·7 per cent. on the bushes under natural conditions in the open.

The effects of shading (or absence of direct sunlight) have to be considered in at least two directions, *viz.*, on the vegetable cell and also on the lengthening of the time of drying of the wash and the chemical changes involved. *Data* with regard to both points require to be collected.

Conclusions.

1.—It is safe under any weather conditions to spray "Whinham's Industry" with the Lime-Sulphur Wash at sp. gr. 1·005. Probably it is safe under most weather conditions to spray this variety with the wash at sp. gr. 1·01.

2.—It is unsafe, during very hot weather, or if the weather becomes suddenly very hot soon after spraying, to spray "Berry's Early" with the Lime-Sulphur Wash at 1·005 sp. gr. (or even at a lower concentration), as serious defoliation will result.

3.—In dull, warm weather, and in sunny weather, if it is not exceptionally hot, it appears safe to spray "Berry's Early" with the Lime-Sulphur Wash at 1·005 sp. gr., as only very slight defoliation will result.

Diary of General Weather Conditions during the Experiment.

May 26th to 29th.—Scorching sun, light breeze.

,, 30th.—Scorching sun, dull and cloudy later.

May 31st —Hot sun, dull and close later.
June 1st —Scorching sun, strong breeze.
,, 2nd.—Ditto, cloudy at intervals.
,, 3rd.—Rain in night, scorching sun, breeze.
,, 4th.—Scorching sun, strong breeze.
,, 5th to 8th.—Ditto. ditto.
,, 9th.—Windy, cloudy, *warm.
,, 10th.—Cool, cloudy, windy.
,, 11th.—Cool and cloudy.
,, 12th.—Warm and cloudy.
,, 13th.—Cool, cloudy, rain in night, rain afternoon and evening.
,, 14th.—Cool, cloudy, windy, rain most of the day.
,, 15th.—Sunny, breeze, clouds.
,, 16th.—Cloudy, warm.
,, 17th.—Cloudy, warm, heavy rain in night.
,, 18th.—Cloudy, high wind.
,, 19th.—Cloudy, cool, rain.
,, 20th.—Warm, cloudy, heavy rain.
,, 21st.—Cloudy, warm, breeze.
,, 22nd to 26th.—Cool ; heavy rain.
,, 27th.—Warm, sunny, clouds.
,, 28th.—Warm, sunny.
,, 29th.—Warm, sunny, breeze.
,, 30th.—Cool, cloudy, breeze.
July 1st.—Warm, sunny.
,, 2nd to 3rd.—Hot, bright,
,, 4th to 7th.—Scorching sun.
,, 8th.—Ditto.
,, 9th.—Hot, strong breeze.
,, 10th.—Cloudy, breeze.
,, 11th.—Hot sun, breeze.
,, 12th.—Scorching sun, strong wind.
,, 13th.—Ditto. breeze.
,, 14th.—Ditto. ditto.
,, 15th.—Dull, showers.

* "Cloudy" in this Diary indicates that though shorter or longer periods of sunshine might occur through the day, the presence of clouds prevented the heat such as occurred on those days when "scorching sun" is recorded.

July 16th.—Warm, dull.
,, 17th.—Ditto. ditto.
,, 18th.—Hot, cloudy.
,, 19th.—Ditto.
,, 20th.—Scorching sun.
,, 21st to 22nd.—Ditto.
,, 23rd.—Cooler, bright.
,, 24th.—Cloudy, warm.
,, 25th.—Ditto.
,, 26th.—Cool, rain.
,, 27th.—Scorching sun.
,, 28th.—Ditto.
,, 29th to Aug. 19th.—Scorching sun practically all the time.
Aug. 20th.—Heavy thunder-storm, very hot.
,, 21st.—Rain, dull, warm.
,, 21st to Sept. 6th.—Warm, bright sunshine, occasional showers, sometimes hot, dull at intervals.
Sept. 6th.—Hot, scorching sun.
,, 7th and 8th.—Very hot, scorching sun.
,, 9th.—Cooler, cloudy.
,, 10th and 11th.—Hot.
,, 12th and 13th.—Cooler, dull, cloudy.

THE AMERICAN GOOSEBERRY MILDEW.

(*Sphaerotheca mors-uvae* (Schwein.) Berk.)

The following account of the present state of affairs with regard to the American Gooseberry-mildew in Kent* is taken from the Reports prepared by Mr. R. S. Vinson, the Inspector appointed by the Kent County Council under the "Destructive Insects and Pests Act, 1907."

In 1911 the mildew first appeared in the county on May 16 attacking the fruit. Under the weather conditions at that time of year, it spread rather rapidly for a few weeks. On the advent, however, of continuous, dry, very hot weather, the gooseberry bushes soon stopped making wood, and on this happening the mildew too in many instances stopped its growth, before it had affected many of the shoots. However, the early ripening of the disease made it necessary to cut off and destroy the diseased shoots sooner.†

During May, following instructions sent down by the Board of Agriculture, *compulsory spraying notices* were served, but only in those cases where the Local Inspector considered it necessary to save the fruit. In the majority of cases the grower was simply *advised* to spray, it being pointed out to him that it would probably save a good deal of the wood from becoming infected. A fair amount of spraying was done, with good results.

The progress of the disease in the three districts Swanley, Maidstone and Sandwich has been as follows:—

Swanley District:—

In October, 1911, the acreage of infested plantations, in comparison with the previous years, was as shown on next page.

* See this *Journal*, Vol. XV., p. 231 (1906); Vol. XVI., p. 299 (1907); Vol. XVII., p. 259 (1908); Vol. XVIII., p. 271 (1909); Vol. XIX., p. 331 (1910).

† It is regrettable that in a large number of cases growers omitted to carry this out, deferring the winter pruning until January, 1912, or later (see p. 431.

	No. of plantations infested.	Bad, *i.e.* above 40 per cent. of bushes affected.	General, *i.e.* between 40-15 per cent. affected.	Slight, *i.e.* less than 15 per cent. affected.	Few, *i.e.* from 1-10 bushes affected.	Total.
		Acres.	Acres.	Acres.	Acres.	Acres.
1908	403	393	231	378	232	1234
1909	242	122	84½	250	430½	887
1910	521	279½	208½	635	263½	1387
1911	313	161¾	63¼	403	445¼	1073

Of this total of 1073 acres, newly planted plantations account for twenty five acres. There are 378 acres, infested last year, which have so far shown no disease during 1911.

The outbreaks appeared in the following months:—

May	.. ..	8 cases.
June	.. ..	84 ,,
July	.. ..	109 ,,
August	.. ..	60 ,,
September	.. ..	43 ,,
October	.. ..	9 ,,
Total	.. ..	313 cases.

In many of the plantations where disease was bad in 1908, it is now considerably less. As a general rule this improvement—the Inspector considers—can be traced to the early removal in autumn of diseased shoots ; there are however exceptions.

With regard to the infestation of fruit, the figures are as follows :—

Number of cases where mildew appeared on fruit :

1910	..	12 cases.
1911	..	49 cases.

Of these forty-nine cases, in only six cases were there more than a few berries diseased here and there. Had the crop not been immediately picked, however, in the earlier cases, it is possible that the disease would have spread. In the six

cases where the disease was worse, it was confined to a small patch in the plantations. In all cases growers were required to have the diseased berries sorted out and destroyed.

In the Report presented by the Inspector in January 1912, five more cases of disease were reported, increasing the infested acreage by nineteen acres.

Maidstone District :—

In October, 1911, the acreage of infested plantations, as compared with previous years, was as follows :—

	No. of plantations infested.	Bad, *i.e.* above 40 per cent. of bushes affected.	General, *i.e.* between 40-15 per cent. affected.	Slight, *i.e.* less than 15 per cent. affected.	Few, *i.e.* from 1-10 bushes affected.	Total.
		Acres.	Acres.	Acres.	Acres.	Acres.
1908		225	149	230	316	920
1909		130	65	148	145	488½
1910		222	247	462	295	1226
1911	343	171	223	474	259	1127

There are in this district 1,073 acres, which were free from disease last year. In January, 1912, 557 acres had been inspected and were found to be still free, the remaining 516 acres had yet to be inspected.

The disease first re-appeared in this district on May 17th, the subsequent outbreaks appearing as follows :—

May	..	..	30 cases.
June	..	..	52 ,,
July	..	..	93 ,,
August	..	..	125 ,,
September	..	..	41 ,,
October	..	..	2 ,,
Total	..	..	343 cases.

With regard to the infestation of fruit, the figures are as follows :—

Number of cases where mildew appeared on fruit.

1910	..	..	20 cases.
1911	..	..	53 cases.

Of these fifty-three cases with disease on the fruit, in forty-six cases only a few berries were diseased. In three cases the disease was confined to a patch in the plantation, and in three cases the disease was bad all through the plantations. In the last cases the grower sprayed and picked as fast as possible, destroying the badly diseased berries, but he had considerable difficulty in getting the fruit off fast enough to keep ahead of the disease. Two acres of the worst of this have now been grubbed.

Sandwich District:—

In October, 1911, the acreage of infested plantations, as compared with previous years, was as follows:—

	No. of plantations infested.	Bad, *i.e.* above 40 per cent. of bushes affected.	General, *i.e.* between 40-15 per cent. affected.	Slight, *i.e.* less than 15 per cent. affected.	Few, *i.e.* from 1-10 bushes affected.	Total.
		Acres.	Acres.	Acres.	Acres.	Acres.
1908	—	—	—	—	—	—
1909	—	—	5½	4	2½	12
1910	—	9½	65½	167¼	7¼	249½
1911	191	25	39½	137¼	94¾	296½

The disease first re-appeared in this district on May 29th; the subsequent outbreaks appeared as follows:—

May	..	..	3 cases.
June	..	..	27 ,,
July	..	..	15 ,,
August	..	..	100 ,,
September	..	..	32 ,,
October	..	..	14 ,,
Total		..	191 cases

The disease appears to be on the increase in this district. In the January Report the Inspector gives the total acreage infested as 311½ acres.

With regard to the infestation of fruit the figures are as follows :—

Number of cases where mildew appeared on fruit :

1910	..	Nil.
1911	..	9 cases.

Of the nine cases in which some disease was seen on the fruit, six plantations had only a few berries diseased. In three plantations the disease was confined to small patches of a rod or two, being fairly bad in these patches. All diseased berries were promptly destroyed.

In January, 1912, the acreage of infested plantations in Kent stood as follows :—

Swanley District ..	..	1,161	acres.
Maidstone District ..	..	1,064	,,
Sandwich District ..	..	311	,,
Total	..	2,536	acres.*

Concerning these infested plantations the Inspector has reported that the following acreage had been satisfactorily pruned for the disease during the autumn or early winter of 1911.

Swanley District ..	..	682	acres.
Maidstone District	..	833¼	,,
Sandwich District ..	..	160	,,
Total ..	..	1,675¼	acres.

Now the important point is this,—*that with regard to the remaining plantations, comprising no less than* 860¾ acres, *the winter pruning for the removal of the disease was not yet completed by January 9th,* 1912.

This neglect on the part of many growers to carry out in the autumn the pruning to remove the winter-stage of the mildew on

* Twenty-five acres of infested plantations were voluntarily grubbed ; no compensation was given.

the young shoots must be regarded as a very serious feature. In this *Journal* for 1909 I wrote: "The only measures which can be taken against the winter stage of the American Gooseberry mildew is the collection of the parts on which it is formed and their destruction by burning. All the diseased shoots bearing any trace of the 'winter-stage' should be pruned off from the Gooseberry bush and promptly burned. *This work must be done quite early in the winter—if possible by the end of October—as otherwise there is great danger of the fruit conceptacles* (PERITHECIA), *with their contained winter spores* (ASCOSPORES) *falling to the ground and thus constituting a source of infection during the following Spring.*"

Where the Winter pruning is delayed far into the Winter, the soil under the bushes is practically certain to become infested, with the result that the work and expense of pruning these plantations are to a large extent wasted. Further, diseased plantations that have not been pruned by the end of the year must be regarded as a menace to the whole neighbourhood; outbreaks of the mildew will in all probability—owing to the soil infestation—appear early in May, and start the disease for the season. Under suitable weather conditions the mildew will spread rapidly by means of its "summer stage," and put the crop of berries in jeopardy—as occurred in several places in Kent last season.

In my opinion, it is absolutely necessary—in order to give the existing measures an opportunity of showing to what extent they can control the American Gooseberry-mildew—*that the autumn pruning of diseased bushes is uniformly enforced over the whole of Kent.*

The following extract, reporting the proceedings at the Meeting of the Kent County Council, held on February 21st, is taken from the *Kentish Gazette* of February 24th, 1912:—

"*American Gooseberry Mildew.*—The acreage in the County now known to be infected with this disease is 2,536 acres, being a slightly larger extent than was known to be infected at the date of the last report. Of this total, 1,161 acres are in the Swanley District, 1,064 acres in the Maidstone District, and 311 acres in the Sandwich district. The most unsatisfactory feature of the Inspector's report is that on the 9th of January, when he reported no less than 960 acres had not been

completely pruned to his satisfaction. It is much to be regretted that growers are not more prompt in carrying out the Inspector's requirements. The Board of Agriculture from time to time suggests that legal proceedings should be taken, but your Committee have not hitherto consented to this being done, as they hoped that owners would be more ready than they have been to co-operate in the efforts which are being made to check this disease.

" Mr. Amos asked if Mr. Quested thought the money spent on this mildew treatment was worth spending. They should do the whole thing thoroughly or drop it altogether.

" Mr. Quested said that when they saw the Board of Agriculture about it twelve months ago they were asked not to drop it, and were told if they did the Board themselves would administer it. At present the Council were receiving from the Board £75 for each of the two officers."

ECONOMIC MYCOLOGY AND SOME OF ITS PROBLEMS *

Economic Mycology—or the study of Fungous Diseases of cultivated plants—is a branch of Mycology which has only very recently received any serious attention in this country. The economic importance of a thorough and systematic control of the fungous diseases of our cultivated plants—carried out both by the State and by the individual grower—is indeed hardly yet recognised in this country, whereas in the United States, and also in our Colonies, this fact has been realized and energetic action taken for the past twenty years. It is satisfactory to be able to record that at last steps are being taken in this country in the same direction. The first recognition by our Government of the importance of controlling fungous diseases was shown in 1907, in which year the "Destructive Insects and Pests Act" became law. Under this Act powers are given to our Board of Agriculture to deal with insect and fungous diseases of plants by measures similar to those employed by them against such contagious diseases of animals as foot-and-mouth disease, swine fever, glanders, etc. There are now some half-dozen special inspectors attached to the Board of Agriculture, and an increasing number of similar inspectors employed by County Councils, who travel about the country making investigations and collecting statistics with regard to certain scheduled fungous diseases of plants. The *educational* effect of this Act during the four years since it has been in force has already been considerable; both on farmers and fruit-growers and also on the Board of Agriculture itself. When the scientific side of the Board of Agriculture has been strengthened, so that this Act is administered with more scientific judgment, this recent piece of legislation will prove of direct *practical* importance.

* Presidential Address delivered before the British Mycological Society at the Annual Meeting, held at Taunton, on Sept. 20th, 1911.

The chief fungous disease which has been proceeded against under the Act is the American Gooseberry-mildew (*Sphaerotheca mors-uvae*). Orders have been issued prohibiting the importation of all gooseberry bushes from foreign countries, and putting in force such measures as the compulsory pruning in winter of affected bushes, the prohibition of the sale of diseased stock, or its removal except under licence. In several counties—though not, it can be said to its credit, in Kent—a few growers have failed to carry out the prescribed measures, and have been summoned before magistrates and fined. Although, perhaps, it may seem somewhat brutal to view it in such a light, a public fine is an excellent educational instrument. When such a thing happens, and is duly reported in the press, that important person, "the man in the street," hears of plant diseases and the possibility of combating them, and an enlightened public opinion is gradually created. That no protests against the infliction of these fines have been made by growers generally, shows perhaps that as a body they have come to recognise the economic necessity for compulsory measures for the protection of their crops from new contagious diseases.

It is within the last five years or so, too, that serious attention has been given by the individual grower to the question of combating fungous diseases. It is true that for many years past in certain districts potatoes have been sprayed against potato "blight," but it is only quite recently that this practice is becoming widespread, and that spraying against fungous diseases generally on a commercial scale is being adopted by the grower of fruit and vegetables in county after county. The fruit-grower is just realizing—to take two instances—that the very existence of commercial apple-growing depends on his learning how to deal successfully with two fungous diseases—Apple "Scab" (*Venturia pomi*) and Apple "Canker" (*Nectria ditissima*), and that he will lose his plantation of "Victoria" plums, tree by tree, unless he takes steps to prevent the "Silver-leaf" fungus (*Stereum purpureum*) from fruiting and spreading.

Before a scientific audience such as this I do not intend to dwell on the purely economic side of the subject; such matters as statistics which show the heavy loss caused

annually by fungous diseases, or points such as the various methods of spraying, and the results obtainable,—or whether it is equitable or not to pay compensation out of public funds for crops compulsorily destroyed,—all such points which are concerned with the commercial side of the subject, while of vital importance to the practical man, must necessarily be comparatively uninteresting to the scientist.

The problems to which I wish to refer on this occasion are purely scientific ones, and among them are some to whose elucidation members of our Society, as well as those of local Natural History Societies, could, I think, bring assistance.

One important problem may be stated thus:—what is the *economic* importance of that specialization of parasitism now proved to exist in many fungi? We find this specialization carried to a high degree in the "powdery mildews" (*Erysiphaceae*) and in the "rusts" (*Uredineae*). I will select a few examples from the first group to show the nature of the problem with which we are confronted. If we take a species of the *Erysiphaceae* which occurs on a number of host-species, it can be shown by inoculation experiments that any one form on a given host-species *a* possesses different powers of infection from the form on host-species *b*. Such forms of a species are identical *morphologically*, but differ *physiologically* or *biologically*, as is shown by their different powers of infection. These forms are termed "biologic forms." Now with this discovery it follows that before the real nature of any immunity to disease shown by a plant can be determined, the extent of the specialization of parasitism reached by the parasitic fungus must be ascertained. Let us take an actual case to illustrate this point. I have shown* by repeated inoculation-experiments that spores of the forms of *Erysiphe Graminis* on *Bromus commutatus*, *B. interruptus*, *B. hordeaceus*, *B. velutinus*, and *B. secalinus* when sown on the leaves of *B. racemosus* are totally unable to cause any infection. Thus we might have plants of *B. racemosus* surrounded by a belt of mildewed plants belonging to the five species of *Bromus* mentioned above remaining completely "immune" although spores of *E. Graminis* were blown on to its leaves night and

* "On *Erysiphe Graminis* DC., and its adaptive parasitism within the genus *Bromus*" (Annal Myc., II. (1904)).

day. An observer of this fact might naturally infer that *B. racemosus* was immune to the attacks of the morphological species *E. Graminis*, but he would be wrong. We find that *B. racemosus* is in nature often virulently attacked, but only by its own specialized " biologic form." If then to that belt of mildewed grasses surrounding the plants of *B. racemosus* which remained "immune" were added one mildewed plant of *B. racemosus*, the " immunity " would at once disappear. It is probable that such cases of partial resistance, *i.e.*, resistance to most, or all but one, of the numerous specialized forms of a fungus, are not uncommon. Such cases appear inexplicable—or are falsely explained—until the specialization of parasitism reached by the fungus is investigated.

Now the problem is : what is the exact *economic* importance of this specialization of parasitism ? The " biologic form " of a parasitic fungus has its limited powers of infection as sharply defined in all the stages of its life-history (conidial and ascigerous, in the case of the *Erysiphaceae*) and must obviously therefore be considered an important " entity " for the economic mycologist. For if a particular host-species of a morphological species of fungus remains *under all conditions* " immune " to all but its own " biologic form," then the combating of certain plant-diseases will be simplified. Take the case of the Hop-mildew (*Sphaerotheca Humuli*), which in many years is the cause of very heavy losses to the hop-grower. The morphological species *S. Humuli* occurs on a large number of wild plants, many of them weeds likely to occur in the neighbourhood of hop-gardens, *e.g. Potentilla reptans*, *Spiraea Ulmaria*, *Alchemilla arvensis*, *Epilobium* spp. We know now* that *S. Humuli* consists of a number of " biologic forms," each confined to one or more species of a particular genus of host-plants. If it is a fact that none of these " biologic forms " can *under any circumstances* infect the hop, the removal or spraying of weeds affected with " hop-mildew " is totally unnecessary.

Certain facts are known, however, which show that the " immunity " of some host-species may be affected in various ways. Thus, to take an actual instance, the spores of the

* *Salmon, E. S.*, in " The New Phytologist," vol. III, (1904) ; *Idem*, in *Journ. Agric. Science*, vol. II. (1907).

"biologic form" of *Erysiphe Graminis* found in nature on *Bromus racemosus* are unable to infect *B. commutatus*; they can, however, infect *B. hordeaceus*. Now the spores of the "biologic form" found in nature on *B. hordeaceus* are able to infect *B. commutatus*. Actual experiment has proved* that if spores are taken from *B. racemosus* and sown on *B. hordeaceus*, and the spores of the resulting generation sown on *B. commutatus*, infection readily results.

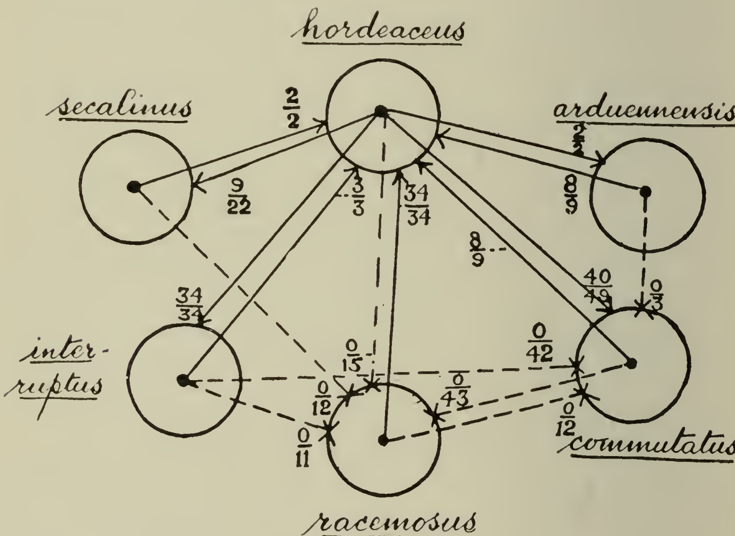

Diagram illustrating the position of *B.* "*hordeaceus*" as a "bridging species." *B.* "*hordeaceus*" is infected by the forms of *E. Graminis* on *B. racemosus*, *B. interruptus*, and *B. arduennensis*, and the fungus occurring on *B.* "*hordeaceus*" is able to infect *B. commutatus*. (The number of inoculations made, and the results obtained are expressed in the form of a fraction, in which the numerator indicates the number of times in which infection resulted, and the denominator the number of leaves inoculated.) Assuming that the fungus produced on *B.* "*hordeaceus*" by inoculation with conidia from *B. racemosus*, *B. interruptus*, and *B. arduennensis* is able to infect *B. commutatus*, *B.* "*hordeaceus*" will serve as a "bridging species" enabling the forms of the fungus on these three host-plants to pass on to *B. commutatus*, a species which they are unable to infect directly. That such is actually the case with regard to *B. racemosus* and *B. commutatus* has been proved by experiments—see Diagram below.

* *Salmon, E. S.*, Recent Researches on the Specialisation of Parasitism in the *Erysiphaceae* ("The New Phytologist," vol., III. 1904), where a bibliography of the subject is given.

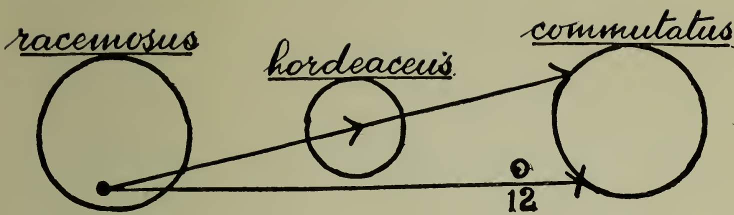

Diagram illustrating the result of experiments. *B.* "*hordeaceus*" is here shown to serve as a "bridging species," affording the fungus on *B. racemosus* a passage to *B. commutatus*, a species which this fungus is unable to infect directly.

So that *B. hordeaceus* acts as a "bridge"—or "bridging species" as I have termed it—enabling the form of the fungus on *B. racemosus* to pass on to *B. commutatus*—a species safe against its direct attacks. The "immunity" of *B. commutatus* would remain absolute if surrounded by a belt of mildewed plants of *B. racemosus*, but if a perfectly healthy plant of *B. hordeaceus* were placed among them, *B. commutatus* would soon become infected. The facts presented graphically in the first diagram given above render it almost certain that the existence of such a species as *B. hordeaceus* will considerably affect the "immunity" of other host-species. It seems possible that the intervention of "bridging species" accounts for the fact that we have powdery mildews in the conidial stage present year after year on species of plants which never show the ascigerous stage of these fungi, *e.g.*, the common garden species of *Myosotis* become mildewed each season, although so far as is known no perithecia are formed on this host-genus.

Another direction in which "biologic forms" may acquire wider powers of infection lies possibly in the lessened "vitality" of the cells of a host-plant. I have shown by experiments* that if the "vitality" of the leaf of a host-plant is affected by subjecting the leaf to heat, or to anæsthetisation, or if the leaf is mechanically injured by pressure or by having pieces cut out of it, or eaten out of it by slugs, then that

* *Salmon, E. S.*, "Cultural Experiments with 'biologic forms' of the *Erysiphaceae*" (Phil. Trans. Royal Society, vol. 197 (1904); *Idem*, in "Annals of Botany," vol. 19 (1905).

leaf, or certain of its cells, are able to be infected by "biologic forms" which under normal circumstances are unable to do so. To what extent, if at all, does this happen in nature? Do plants whose leaves are injured in any way—and it is rare to find a fully-grown leaf that does not show some minute injury—become infected by "strange" "biologic forms"? Does, for example, the practice of rolling wheat, whereby many of the leaves are bruised, render this plant liable to the attacks of the "biologic forms" on barley and on oats, which we know are unable to infect uninjured leaves of wheat? A case came under my observation* where, apparently, plants of *Hordeum secalinum* became susceptible only when the health of the plants was impaired by unfavourable cultural conditions. In other cases there has been some evidence that susceptibility has been induced by the attacks of "green fly" (*Aphis*) on a plant. In the case of the hop, and of a number of other cultivated and also wild plants, it is noteworthy how frequently an attack of powdery mildew is coincident with an attack of "green fly."

In leaving the subject of specialization of parasitism, it must be pointed out that with regard to the majority of diseases caused by parasitic fungi—many of them of great economic importance—we are still in ignorance as to whether this specialization occurs or not. Until this knowledge is obtained, the economic mycologist is at a loss to answer many questions put to him by the practical grower. For example, the fungus *Nectria ditissima*, which is the cause of the "canker" disease of the apple—a disease which has ruined many a plantation and indeed put many varieties of apples out of cultivation—occurs also on the pear and on a large number of our wild trees, such as the ash, beech, oak, hornbeam, and others. Whether this fungus has become specialized to its different host-species we do not know. An instance occurred recently where a fruit-grower planted up a field with apple trees, and then found in the hedges surrounding this field ash-trees badly infested with *Nectria ditissma*. In our present state of knowledge it is impossible to say what danger to the health of the apple-trees

* *Salmon, E. S.*, Cultural Experiments with the Barley Mildew (Annal. Myc., Vol. 2. (1904).

was incurred by the proximity of the "cankered" ash-trees.*

Another problem which confronts the economic mycologist is this: what degree of importance from the economic point of view is to be attributed to the *saprophytic* stage in the life-history of a fungus causing a plant disease. As an instance typical of this class of diseases, I would cite the Apple and Pear "Scab" (*Venturia pomi* and *V. pirina*), which ruins tons of apples and pears every season in this country. In the life-cycle of these species the conidial stage is *parasitic* on the fruit, leaves and young wood; the ascigerous stage develops as a *saprophyte* in the dead, fallen leaves. This saprophytic stage has been recorded from the United States, and from the Continent, where it is said to be not uncommon, but it has not, as yet, been recorded from this country, although very probably it occurs here. In such a life-history as this—which obtains in a fairly large class of plant diseases—what importance in connection with the annual outbreaks of the disease is to be attributed to this saprophytic stage? I have shown† that at any rate in mild seasons in this country the parasitic, conidial stage winters over on the young shoots of the apple or pear, but have we as well centres of infection from these fungi existing as saprophytes? Another case is that of the common and often destructive disease of the Gooseberry known as "Die-back," or "Collar-rot," caused by *Botrytis cinerea*, which is ubiquitous as a saprophyte. To what extent *parasitic* outbreaks of this disease proceed from *saprophytic* centres of infection is at present quite unknown.

Another very important question is: what are the conditions under which some saprophytic species of fungi become parasites. Exact knowledge on this point is much wanted at the present time with regard to the most destructive disease known as "Silver-leaf"—which is laying waste whole plantations of plums and, indeed, beginning to threaten the very existence of one of the best varieties of cultivated

* Goethe records (Landw. Jahrb. IX. [1880]), that ascospores of *N. ditissima* obtained from the Beech infected the Apple, and conversely; also that conidia of this fungus taken from the Apple infected the Beech and *Acer Pseudo-platanus*, but not the Horse-Chestnut nor *Ulmus montana*.

† *Journ. S. E. Agric. Coll.*, Vol. 15 (1896).

plums, *viz.*, the "Victoria." Through the work of Prof. J. Percival,* and of Mr. Spencer Pickering,† we know that this disease is caused by the fungus *Stereum purpureum*. Now *S. purpureum* is accounted a very common saprophyte, occurring on the trunks and branches of dead trees, particularly on dead firs and on birch stumps. Under what conditions does this fungus become parasitic—does it need merely the proximity of a Plum tree to make it change its habits? Is this fungus as a rule entirely saprophytic, or has it previously killed those trees on whose dead wood its fructifications so commonly occur? Or are there two strains, or races, of *S. purpureum*—a saprophytic and a parasitic one?‡ A careful study by field mycologists of the prevalence and habits of *S. purpureum* in different districts would be of the greatest help to the economic mycologist.

Another interesting problem—the solution of which would probably throw considerable light on the nature of the parasitism of certain fungi—may be stated thus: What are the conditions under which a parasitic fungus attacks a new host-species? Two striking instances among the *Erysiphaceae* have recently occurred in this country. The European Gooseberry-mildew (*Microsphaera Grossulariae*), which has been known in this country, probably for over a hundred years, as a common and comparatively harmless pest of the cultivated Gooseberry, was noticed, four years ago, in one of the fruit plantations at Wye College, Kent, on a number of Red Currant bushes. In the following years I observed it again on the same Red currants, and also on Red Currants on three different fruit-farms in other parts of Kent. Now the European Gooseberry-mildew has never before been recorded in any country as attacking the Red Currant. It is scarcely

* *J. Percival*, "Silver-leaf Disease" (Journn. Linn. Soc., Vol. 35 [1902]).

† *S. U. Pickering* (Woburn Experimental Fruit Farm, Sixth and Twelfth Reports, 1906 and 1910).

‡ Grossenbacher and Duggar have recently stated (New York Agric. Exper. Station, Bull. 18 [1911]), that they consider, from the results obtained in comparative inoculation experiments, that *Botryosphaeria Ribis* (which kills the shoots of Currants in the United States), is made up of two *physiologically distinct* fungi within the morphological species. "Both forms are present on the bushes of a blighted plantation, yet only one of the forms is an active parasite."

conceivable, that had it done so, its occurrence could have been passed over, as it is very conspicuous, and these "powdery mildews" have always been collected assiduously. It must be noted, too, that this fungus has had the opportunity—as regards the proximity of this new host-species—for a very long time, for Red Currants and Gooseberries are commonly grown side by side in fruit plantations and gardens, yet until lately it has not, apparently, been able to attack the Red Currant. Does this indicate some change on the side of the fungus ; or is it that in the course of the cultivation of the Red Currant new varieties have been produced which are susceptible to this mildew ; or is it, possibly, that the older varieties of the Red Currant have, through continued cultivation, arrived at a state in which they are no longer immune ? The second case is that of the American Gooseberry-mildew (*Sphaerotheca mors-uvae*) attacking the Black Currant. In North America, the home of this mildew, it attacks, besides the native and introduced species of Gooseberries, the Red Currant, but no case has ever been recorded of its attacking the Black Currant. On the introduction of the mildew into Europe, a little before 1900, it began almost immediately to attack the Black Currant ; I have seen it on this host in several localities in Kent, where apparently it had spread from badly-infested Gooseberry bushes, and it has been found also in several places on the Continent. A case somewhat related to the last is that of the "downy mildew," *Plasmopara viticola*, and certain species of *Vitis*. When this mildew invaded Europe, certain American species of *Vitis*, which in their native country suffer but little from the attacks of this mildew, proved very susceptible when cultivated in Europe. What is, apparently, another case of a new host-plant being attacked has lately occurred with consequences likely to be of the greatest economic importance. One of the "scheduled" plant diseases now being proceeded against —or at any rate watched—in this country under the new Act, is the "wart disease" or "black scab" of the potato,—a disease which is capable of completely destroying the potato crop in badly infected soil. This disease is due to the fungus *Synchytrium endobioticum*, which was first described a few years ago on the potato in Hungary. It seems probable, how-

ever, that this parasite has existed previously somewhere on the Continent, on some native plant as yet undiscovered, and has recently passed from this plant to the potato as a new host.

One other case may be mentioned where we find, apparently, a fungus learning to attack—so to speak—new host species. *Stereum purpureum*—the Silver-leaf fungus, referred to above, has it seems, according to the testimony of growers, during the last ten years or so extended its attacks to Apple and Cherry trees. One particular variety of apple, "Lord Suffield," is now attacked by "Silver-leaf" with increasing frequency.

I should like to mention also a set of problems connected with the methods of combating fungous diseases. The methods of combating diseases can be divided into three. (1) external treatment of the host-plant; (2) internal treatment of the host-plant; (3) selection or breeding for resistance to disease.

In the first method the plant is sprayed with a chemical substance, or combination of chemical substances, which either directly kills the fungus present—e.g., sulphur and copper sulphate—when it may be called a *direct fungicide*; or which protects the parts sprayed against external infection, *e.g.* Bordeaux mixtures, which are *protective fungicides*. In each case we require exact knowledge on (*a*) the chemical nature of the fungicide, and (*b*) the effect of the fungicide on the vital activities of the fungus and (if any) on those of the host-plant. It must be admitted that our knowledge here is still very incomplete. Although sulphur and sulphides of potassium have been in common practical use for a very long time, we are still in almost entire ignorance as to their action on the fungus. In the case of Bordeaux mixture, discovered about 1875, it was not until 1907, when Mr. Spencer Pickering carried out his researches,† that its chemistry was elucidated. Bordeaux mixture is the best and most widely-used of all fungicides, yet its exact fungicidal action is still a matter of dispute. According to what may be termed the *chemical* explanation, put forward by Mr. Spencer Pickering,

† *S. U. Pickering*; "The Chemistry of Bordeaux Mixture" (Woburn Experimental Fruit Farm, Eighth Report (1908).

it is due to copper sulphate liberated from insoluble basic sulphates of copper by atmospheric carbon dioxide ; according to the *biological* explanation, advanced by Swingle, Clark, Schander and others, and supported by the important recently published work of Messrs. Barker and Gimingham,* the fungus itself acts on the insoluble copper compound in such a way as to poison itself. Many important practical points in the treatment of plant diseases stand to be affected by any advance in our scientific knowledge on the present subject.

If the biological explanation of the fungicidal action of Bordeaux mixture is correct, then we have scientific grounds for emphasizing the importance of two practical points in the making and application of Bordeaux mixture. Messrs. Barker and Gimingham believe that the fungus acts on the insoluble copper compound only when there is actual contact between the fungus and the particles of the insoluble copper compound. Therefore in making Bordeaux mixture, that practical method should be followed by which the copper precipitate is obtained in as finely divided a state as possible ; and, secondly, it follows that Bordeaux mixture should be applied in as finely divided a spray as possible so as to deposit very minute drops uniformly over the surface of the sprayed part.

Another very important problem concerns the nature of the injuries which occasionally occur on plants after they have been sprayed. A form of injury known as "Bordeaux injury," which follows the use of Bordeaux mixture on some varieties of fruit-trees, is often so severe that it has led to the abandonment of the use of this valuable fungicide on the varieties in question. In connection with this problem—which is continually being brought to his notice by the practical grower—the economic mycologist has to study many non-mycological matters such as the different degrees of susceptibility to this injury shown by the various "varieties" of cultivated plants ; the effect of different meteorological conditions on foliage and fruit before and after spraying—and

* *B. T. P. Barker* and *C. T. Gimingham* ; "The Fungicidal Action of Bordeaux Mixture" (*Journ. Agric. Science*, vol 4. [1911] ; *C. T. Gimingham* ; "The Action of Carbon Dioxide on Bordeaux Mixtures" (*l.c.*).

so forth. Experiments carried out at Wye during the past season have shown that under certain weather conditions gooseberry bushes are almost completely defoliated when sprayed with a certain lime-sulphur spray, which under other weather conditions is harmless to them. Further, susceptibility to injury from this spray varies very greatly according to the variety of gooseberry. It has also been shown* that a particular variety of apple which is very susceptible to " Bordeaux injury " may be safely sprayed with a lime-sulphur spray.

Also, such practical points as the following must be considered to lie within the field of work of the economic mycologist ; the selection of different types of spraying machines and nozzles for use with different sprays and for different crops ; and the testing of the comparative efficiency and cost of hand-, petrol-, compressed air- and steam-power for spraying. He should be acquainted, too, with the most economical use of labour in the work of spraying, and also of the best systems from his special point of view of the planting up, and subsequent management, of the orchard and plantation. In parts of Kent the practice of spraying has already become so firmly established that the most progressive fruit-growers are now laying out from the start their fruit plantations in such a way that spraying can be most efficiently and economically carried out.

The second method of combating fungous diseases is by injecting into the plant, or by making its roots take up, some substance which absorbed into the tissues will confer immunity against the disease. This method must be regarded at present more as a theoretical way of dealing with diseases of plants than a practical one. In certain directions, however, some success has been reported. Marchal, in 1902, stated† that lettuces are made resistant to the attacks of the lettuce mildew (*Bremia Lactucae*)—a disease which often causes heavy losses to this crop when raised on the French system of gardening—when seedlings are grown in a nutrient solution to which copper sulphate has been added in the

* *Journ. S. E. Agric. Coll.*, Vol. 19 (1910).

† *E. Marchal ;* "De l'immunisation de la Laitue contre le Meunier " (Comptes Rendus, 135 ([1902]).

proportion of 3 or 4 parts to 10,000 parts of water. Massee soon afterwards stated* that cucumbers grown in soil watered with a solution of copper sulphate become " immunised " against the " spot " disease (*Cercospora Melonis*). Mr. A. D. Hall carried out experiments† to test the latter statement, and these showed that it is very questionable if such a result can be obtained. I may refer here to my own experiments,‡ which showed very definitely that seedlings of cereals cannot be made resistant to mildew (*Erysiphe Graminis*) by making them absorb copper. Seedlings of wheat, barley and oats were grown in a series of cultures, and various amounts of copper sulphate added to the nutrient solution ; in every case—even in those where the seedling plant had taken up so much copper that its leaves were stunted in growth and of an abnormal, dark green colour—infection resulted on the leaves of the treated plants as readily as on those of the untreated " control " plants. Cases have been recorded of success following the injection of iron sulphate into the stems of plum-trees affected with " Silver-leaf," but these do not rest on scientific testimony.

The third method—that of obtaining plants resistant to disease by selection or by breeding—is one which is now attracting more and more scientific attention. For dealing with certain classes of diseases—such as the Rusts (*Uredineae*) or the class known as " soil diseases " (*Fusarium*-" wilts," *Oospora*- and *Synchytrium*- " scab," etc.)—this method offers the only solution. Important practical results have already been obtained in this field of work. One of the earliest successes was obtained in the United States, in connection with the " wilt " disease of cotton (*Fusarium niveum*). Dr. Orton, one of the mycologists on the scientific staff of the United States Department of Agriculture, found that in fields of cotton which were badly diseased one or two plants here and there resisted the disease and came to maturity. Seed was collected from these plants, and sown on land very subject to the disease ; seed was collected from those seedlings which again proved resistant, and the operation repeated. At the

* *G. Massee*, in Journ. Roy. Hort. Soc., Vol. 28 (1903).

† *A. D. Hall*, in *Journ. Board Agric.*, Vol. 12 (1905).

‡ *E. S. Salmon*, in Annal. Myc., Vol. 2 (1904).

end of four years plants were obtained of good cropping powers, with good quality of fibre, and with marked powers of resistance to disease. The seed of such plants was distributed by the Department of Agriculture to cotton-growers, and it was then found by general experience that these seedlings survived and produced a good crop in soils where the ordinary strains in cotton were a complete failure. In this case the practical grower quickly realized the importance of selecting for disease-resistance, and is still carrying on the work. In another case, also in the United States, "cross-" breeding between cultivated varieties of the Melon and a wild species of non-edible Citron has been successfully employed. By this means a good edible Melon has been obtained which is resistant to a most destructive *Fusarium*-disease, very similar to the wilt-disease of cotton. In England, through the patient work of Prof. Biffen at Cambridge, wheats of high quality and immune to "rust" (*Puccinia glumarum*) have recently been produced. In this work a "rust-"resistant strain of wheat of low quality was "crossed" with one of high quality but very susceptible to "rust." The resulting "hybrid" plants all proved to be very susceptible to the disease, but these plants, when self-fertilized, gave seed which produced many plants immune to this "rust." Further, Prof. Biffen in his work has established the most important fact* that this susceptibility or resistance to disease behaves as a unit character, its inheritance following the now well-known Mendel's "law." In later work by Dr. Salaman, similar results have been obtained† with "hybrids" of the potato as regards their resistance to the potato "blight" (*Phytophthora infestans*). It is impossible to over-estimate the economic importance of the *data* which have recently been obtained as to the inheritance of disease resistance.

All facts noted in the field that bear on the subject of disease-resistance should be carefully stored by the economic mycologist. Among the "varieties" of nearly all our cultivated plants some stand out as possessing powers of resistance to disease, or show at least what has been lately termed in America "disease endurance." Certain very

* *R. H. Biffen*, in *Journ. Agric. Sci.*, vol. 2 (1709).

† *B. N. Salaman*, in *Journ. of Geneties*, vol. 1 (1910).

suggestive facts in this connection may be noted among our cultivated varieties of apples. The "canker" disease (*Nectria ditissima*) has practically stamped out the commercial cultivation of a number of excellent English apples, *e.g.*, the "Wellington"; and has made that magnificent apple, Cox's Orange Pippin, unprofitable from the commercial point of view. Now one very strong growing variety of apple, "Bramley's Seedling" by name, proves very resistant to "canker." If badly cankered trees are cut and "top-grafted" with Bramley's Seedling grafts, the "constitutional" powers possessed by this variety enable the tree to "grow out" of the disease, so to speak—any "cankers" in the stem or branches of the stock die away or heal over; while if grafts of weaker growing varieties are used on exactly similar stocks, the trees will quickly succumb to "canker"—the disease frequently causing the graft to die where it has been inserted in the stock, or the whole tree dies through starvation caused by the "cankers" increasing on the stem or branches of the stock. By "cross-" breeding with this end in view there could very possibly be produced new varieties of apples having the highest quality and good cropping powers combined with resistance to "canker."

In the work of raising disease-resistant varieties results can only be obtained by trained scientific workers carrying out experiments of many years' duration. We require in this country many more workers in this important field of research; it is much to be hoped that at the John Innes Horticultural Research Station, recently established at Merton, Surrey, under Prof. Bateson, the breeding of disease-resistant plants will be undertaken on an extensive scale.

Finally, I would call attention to the important problem of the education of public opinion to the economic importance of combating fungous diseases. In a book recently published in the United States, by Stevens and Hall, entitled, "Diseases of Economic Plants," these sentences occur: "Much can be done towards the eradication of fungous pests by the creation of a more enlightened public sentiment regarding them. . . . To create a much needed, enlightened, aggressive public opinion is part of the duty of plant pathology." This side of the subject should certainly

not be neglected in this country; the need for enlightening public opinion is considerably greater at present in England than in the United States.

The creation at our Board of Agriculture of a properly equipped Horticultural Department is a reform long overdue. There are many directions in which such a Horticultural Department could move. There is no reason why our Government should not organize great fruit shows as those of other countries do. At such shows important educational exhibits could be arranged and authoritative scientific advice given with regard to plant diseases. Let me give one instance where the spread of scientific information is needed urgently. At the present time the most progressive commercial apple-growers in England and Ireland are beginning to market their best apples in non-returnable boxes, graded and packed in the most approved American and Colonial methods. These up-to-date methods are only possible where the apples have been grown free from the "scab" fungus. The presence of "scab," in an average season, on a large proportion of English apples is the chief reason which at present tends to make the bulk of our crop of apples inferior to that of the leading fruit-growing countries. The fact that in an average season apple trees require to be sprayed to keep off the "scab" fungus is one which requires to be driven home. With an energetic State Horticultural Department the present partial wastage, year after year, of the English apple crop due to the ravages of "scab," "canker," and "brown rot," could be enormously diminished or even stopped.

Further, illustrated articles on the common fungous diseases, with the methods of prevention, should be sent to journals widely read by the public, together with statistics, readably presented, showing the heavy annual losses due to the destruction or deterioration of cultivated plants caused by parasitic fungi. This method of popularizing technical knowledge is widely used in America and in our Colonies. In connection with the cultivation of land in "small holdings," which is now being advocated, it should be pointed out that the intense cultivation of most crops demands for commercial success a sound knowledge of the best methods of combating plant-diseases. In Ireland the farmers are assisted by the

State to purchase potato-sprayers and materials for making sprays ; in connection with any scheme in this country for the creation of Credit Banks for the assistance of "small holders," provision should certainly be made for assisting them with loans for the purchase of spraying machinery and necessaries. Also, some information on the subject of plant diseases might be given in the rural school.

There are many other ways in which the economic importance of the present subject can be brought home to the grower and public generally, and none of these should be neglected by the State. To protect our crops against epidemics of disease caused by fungi and insects further compulsory measures will be required, and it must not be forgotten that for legislation to have its full beneficial effect it always requires to be sustained by an educated public opinion.

NOTES ON HOPS.

BY

E. S. SALMON, F.L.S.

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By E. S. Salmon, F.L.S.

1.—On the Raising of New Varieties of Hops from Seed.

The work of "crossing" different varieties of hops with the object of obtaining new varieties has been continued through 1910. The female parents used for "crosses" were the Canterbury Whitebine, and a "seedling" hop raised from the Early White variety. The male hops used were a variety from Oregon, obtained in 1908, through the kindness of Messrs. Wigan, Richardson & Co., and a late-flowering greenbine English male hop remarkable for its vigour and abundance of flower. Besides the above, seed was collected from the following varieties: Rodmersham Golding; Brambling; a German variety from Hersbruck, near Spalt (grown at Wye since 1902); four "seedling" hops of various parentage; and two "monoecious" hops. Messrs. Wigan, Richardson & Co. kindly supplied some seed from Halladau hops grown in Bavaria, and also of Bavarian market hops.

As was announced in this *Journal*, Vol. XIX., p. 365, we have now in the College hop "nursery" a considerable and increasing number of seedling hops of different parentage, many of which are now available for trial by hop-growers. Several of these "seedlings" have obtained a favourable report in the Borough as to flavour, and show a high percentage of soft resins (see below, p. 456 and p. 465; also this *Journal*, Vol. XIX., p. 367 and p. 379). Some show, also, a very strong growth, and should be tried experimentally by growers on ground where the ordinary varieties of hops become attacked by eelworm or by "canker," as some of these seedlings are likely to possess powers of resistance, if not actual immunity, to these diseases.

During the season of 1910 several hop-growers in Kent visited the College hop "nursery," and selected "seedling" hops, which they considered to show sufficient promise to make them worth testing in the soil of their own hop-gardens. "Cuts" of the hops thus selected were supplied to the grower the following autumn. In most cases the seedlings thus selected were ones already tested by the College as to vigour of growth and fruitfulness, and of which favourable reports as to flavour had been obtained from Factors and Merchants in the Borough. 241 "cuts" of nine different varieties of hops raised at the College were sent out, by request, to be grown experimentally (a few hills of each) by six hop-growers in different districts in Kent. By this means the behaviour of the various new varieties in different soils and under different methods of cultivation, will be ascertained.

The College experimental hop-garden and "nursery" are open to inspection at any time by hop-growers in Kent or Surrey.

During the season of 1910, as in previous seasons, hops from various selected hills of "seedlings" and other varieties were picked and dried separately and the "box samples" submitted to factors and merchants in the Borough. The reports obtained as to flavour are given below, together with notes on the character of growth shown by the respective plants in the experimental hop-garden at the College. Owing to a late and persistent attack of "blight" (*Aphis*) in the College hop-garden, some of the samples, when collected, contained "lice"; this of course rendered these samples uneven, and so greatly increased the difficulty of obtaining satisfactory duplicates for the determination of the percentage of resins (see below, p. 465). On the other hand, the occurrence of this late *Aphis* attack served to show what resistance to "blight" different varieties of hops possessed; some observations on this point will be found below.

Class I.—Of Unknown Parentage; believed to be "Seedlings."*

Ref. No. A 2.—Fairly vigorous and fruitful; bine red or striped; hop large, green or occasionally with slight

* For the soft resins contents of these hops, see the table at p. 465.

reddish tinge, very occasionally leafy, of distinct, "papery" (*scarious*) appearance. Plant susceptible to "mould," but appears to be resistant to *Aphis*. May be useful as parent.

1910.—"Nothing in it; practically no flavour" (Factor B).

Ref. No. B 7.—Very vigorous and very fruitful; bine striped; hops thick, green, or in some seasons with a tinge of red. Not quite ripe when picked.

1910.—"Very nice hop; good flavour; full of condition; should place it first of all the samples in this Class" (Factor B).

†*Ref. No.* B 9.—Fairly vigorous and fruitful; red bine; early-medium; hop very large and long. (Hops when ripe with *Aphides* in them.) May be useful as parent; might possibly be grown seedless.

1910.—"Excellent hop, with rare good flavour, not Golding, but excellent flavour, much milder than Fuggles, and might replace it" (Factor A); "not a Golding as to growth; flavour fair and can be called a Golding flavour, but could *not* replace Fuggles, being inferior; worth going on with" (Factor B).

†*Ref. No.* B 10.—Vigorous and fairly fruitful, green bine; early-medium; hop rounded, thick. (Hops when ripe with *Aphides* in them.)

1910.—"Distinctly good flavour" (Factor B).

†*Ref. No.* B 14.—Very vigorous and fruitful; green bine; hop large, coarse, long; laterals of medium length; hops thickly set. Distinct-looking hop; appears to be resistant to *Aphis*; may be useful as parent.

1901.—"Flavour very distinct and nasty" (Factor B).

†*Ref. No.* B 18.—Very vigorous and very fruitful; striped bine; late hop; laterals of medium length; hops thickly set; hop oval, rather small. Hops were not quite ripe when picked.

1910.—Twenty bushels of hops were picked from thirty-five hills of this variety (planted from "cuts" in

† indicates that a sample of this hop was submitted to Factors in previous seasons (see this *Journal*, Vol. XIX., p. 367).

1908-9); these were dried separately, and put into a pocket. An ordinary commercial sample was submitted to Factors. "Comes below Canterbury Whitebine; lacks refinement and has ranker flavour; has more rub than a Cobb's Golding, and is decidedly superior to that" (Factor A); "is not a Golding; has rank flavour, which is the Colegate flavour, pure and simple; should not be grown" (Factor B); "of full flavour, *not rank*,—worth going on with" (Factor D).

Brewing trials are being made of this hop.

Ref. No. B 20.—Fairly vigorous and very fruitful; green bine; very early; hop large, thick, green. (Hops when ripe much infested with *Aphides*.)

1910.—"Shows some promise; should be kept" (Factor B).

†*Ref. No.* C 1.—Very vigorous and very fruitful; green bine; hop small, rounded. (Hops very small, many when ripe infested with *Aphides*.)

1910.—"Not Golding flavour, but good hop" (Factor A); "this is a good hop" (Factor B).

Ref. No. C 5.—Not vigorous but fruitful; striped bine; foliage inclined to yellowish tinge; early; hops thickly set on laterals; hop small.

1910.—"Good looking hop, worth saving perhaps; flavour very mild" (Factor B).

†*Ref. No.* C 13.—Vigorous and very fruitful; striped bine; hops thickly set on laterals; hops small, thick.

1910.—"Flavour very nice; not bad hop, but does not stand out" (Factor B).

†*Ref. No.* D 8.—Fairly vigorous and fruitful; striped bine; among the early hops; laterals short; hops thickly set. (Hops when ripe infested with *Aphides*.)

1910.—"Does not appeal to me" (Factor B).

†*Ref. No.* D 9.—Vigorous and fruitful; red bine; among the early hops; laterals short; hop very large—the largest in the nursery. May be useful as a parent; might

† indicates that a sample of this hop was submitted to Factors in previous seasons (see this *Journal*, Vol. XIX. p. 367).

possibly be grown seedless. (Hops when ripe infested with *Aphides*.)

1910.—" A coarse hop, not choice flavour " (Factor A); " rubbish, nothing in it as it is " (Factor B).

†*Ref. No.* E 14.—Very vigorous and fruitful; very red bine; laterals long; hop occasionally tinged red. (Hops when ripe with a few *Aphides* in them.)

1910.—" Not choice " (Factor A); " not good enough " (Factor B).

†*Ref. No.* F 1.—Very vigorous and very fruitful; green bine; early-medium. (Hops when ripe with a few *Aphides* in them).

1910.—" Not special " (Factor B).

†*Ref. No.* F 21.—Vigorous and fruitful; red bine; among the late hops; laterals long, hops rather scattered; hop long, imbricated. May be useful as parent.

1901.—" Nothing in flavour to recommend it " (Factor B).

Samples of seven other hops which were dried were considered by all the factors to show no promise as regards flavour; as these plants showed no marked promise in other directions they have been grubbed up.

Class II.—Seedling Hops of Known Parentage.*

Ref. Nos. 38, 49, 53, 54, 125.—*Early White* × *male growing among Early Birds*).

†*No.* 38.—Very vigorous and fruitful; laterals rather long, hop rounded.

No. 49.—Vigorous and fruitful; early; hop large, rounded. (Hops when ripe with some *Aphides* in them).

†*No.* 53.—Vigorous and fruitful down to breast wire; laterals short. (Hops when ripe with some *Aphides* in them; also wind-bruised.)

No. 54.—Vigorous and fruitful; early; laterals medium length; hop large, rounded. (Hops when ripe infested with *Aphides*).

* For the soft resins contents of these hops see the Table at p. 466.

† indicates that a sample of this hop was submitted to Factors in previous seasons (see this *Journal*, Vol. XIX. p. 367).

No. 125.—Vigorous and fruitful; laterals short; hops closely set; hop with golden tinge on ripening.

1910.—The above hops were placed by Factor B in the following order of merit, with the remarks, "the first three of first-class flavour, quite equal to Early White," 1st, No. 38; 2nd, No. 125; 3rd, No. 54; 4th, No. 49; 5th, No. 53.

Factor A placed No. 53 1st, with the remark, "a true Golding, but distinct from Early White," the remaining four were pronounced "not worth anything."

Ref. No. 138.—(Fuggles × red-bined male).—Very vigorous and very fruitful; bine green, with splotches of red; hop green, small, pointed, laterals short, with densely clustered hops.

1910.—"Has Golding flavour" and shows promise (Factor B); "not Golding flavour, but a superior or refined Fuggles flavour" (Factor A).

Ref. No. 193.—(Fuggles × red-bined male).—Vigorous and fairly fruitful; green bine with reddish splotches; laterals of medium length; hop green, pointed, pale, "petals" very loosely arranged (*i.e.* distant on strig).

1910.—"No Golding flavour" (Factor A); "has distinct Fuggles flavour,—can detect Fuggles parentage" (Factor B).

Ref. No. 11.—(Fuggles × green-bined male).—Vigorous growth, fairly fruitful; striped bine; laterals short; hop green, medium size, between rounded and pointed. (Hops when ripe infested with *Aphides.*)

1910.—"Has no Golding flavour" (Factor A); "no condition, unripe." (Factor B).

†*Ref. No.* 21.—(Hammond's Wild Hop‡ × green bined male). —Vigorous and fruitful; late hop.

1910.—"Not worth consideration" (Factor A); "shows no promise; is quite different from last season's sample" (Factor B).

† indicates that a sample of this hop was submitted to Factors in previous seasons (see this *Journal*, Vol. XIX., p. 357).

‡ See this *Journal*, Vol. XIX. p. 373.

Ref. No. 76.—(Saaz × male growing among Eastwell Goldings).—Fairly vigorous and fruitful.

1910.—"Powerful hop, full of resins; flavour not good enough for dry hopping" (Factor A); "of distinct flavour, and nothing against it" (Factor B).

Ref. No. 152.—(Canterbury Whitebine × red-bine male).—Vigorous and fertile, bine red.

1910.—"Not Golding flavour; not worth keeping" (Factor A); "Golding flavour" (Factor B).

Ref. No. 19.—(Fuggles × red-bine male).—Very vigorous and fruitful; bine green, in places with green stripes, alternating with red stripes or red blotches; hop green, small, rounded.

1910.—"Nice hop, worth going on with" (Factor A); "flavour excellent, though not a Golding; an improvement on Fuggles" (Factor B).

†*Ref. No. G* 21.—(Colegates × male growing among Canterbury Whitebines).—Very vigorous and very fruitful dense crop of hops; green bine; very late hop,—a week or more later than the Canterbury Whitebine.

1910.—"Mild, Golding flavour" (Factor A); "no Colegate flavour" (Factor B).

Ref. Nos. H 1, *H* 3, *H* 4—(Colegates × male growing among Eastwell Goldings).

H 1.—Vigorous and fruitful; striped bine; laterals short, hops very clustered. May be useful as parent. (Hops when ripe infested with *Aphides* and somewhat windbruised.)

H 3.—Fairly vigorous and fruitful; green bine; laterals rather long; hop small, "buttony." Apparently resistant to *Aphis*; may be useful as parent.

H 4.—Fairly vigorous and fruitful; striped bine; laterals rather short; hop long, closely imbricated, of distinct appearance. Apparently resistant to *Aphis*; may be useful as parent.

† indicates that a sample of this hop was submitted to Factors in previous seasons (see this *Journal*, Vol. XIX., p. 357).

1910.—" I place *H* 4 1st, with excellent, though not Golding flavour ; not like Colegate flavour " (Factor A) ; " I place *H.* 3 first, but does not show much promise, though there may be something in it,—no Colegate flavour,—the two others I consider of no good " (Factor B).

Ref. No. I 4.—(Cobb's Golding × male growing among Eastwell Goldings)—Fairly vigorous and fruitful ; green bine.

1910.—" Not so good as *I* 6 " (Factor A) ; " Golding flavour, better than *I* 6 " (Factor B).

Ref. No. I 6.—Cobb's Golding × male growing among Eastwell Goldings.)—Vigorous and fruitful ; green bine ; laterals long.

1910.—" Quite good Golding flavour, better that *I* 4 " (Factor A) ; " Golding flavour, but thin, papery hop ; not so good as *I* 4 " (Factor B).

Ref. No. I 9.—(Saaz × red-bined early-flowering male).—Vigorous and fairly fruitful ; red bine ; hop closely imbricated. (Hops when ripe infested with *Aphides*.)

1910.—" Inferior to *I* 10 " (Factors A and B) ; " flavour peculiar, inferior to *I* 10 " (Factor D).

Ref. No. I 10.—(Saaz × red-bined early-flowering male).—Vigorous and fairly fruitful ; red bine ; hop large. (Hop when ripe infested with *Aphides*).

1910.—" Not comparable in flavour to English varieties, and would not sell among them, being too strong, yet a good hop " (Factor A) ; " has *slight* German flavour ; worth going on with " (Factor B) ; " good German flavour ; a good hop, with plenty of lupulin ; a hop that as it is would sell well on the market, distinctly superior to *I* 9 " (Factor D).

†*Ref. No. I* 16.—(Cobb's Golding × early-flowering red-bine male).—Very vigorous and fertile ; red bine ; laterals rather long.

† indicates that a sample of this hop was submitted to Factors in previous seasons (see this *Journal*, Vol. XIX., p. 357).

1910.—" Golding flavour, worth going on with, better than *I* 21 " (Factor A) ; " not so good as *I* 21 " (Factor B).

Ref. No. I 21.—(Cobb's Golding × early-flowering red-bine male).—Vigorous and fairly fruitful ; red bine.

1910.—" Not so good as *I* 16 " (Factor A) ; " better than *I* 16, but not my idea of a Golding " (Factor B).

Samples of three other seedling hops which were dried, were considered by all the Factors to show no promise as regards flavour ; as these showed no marked promise in other directions they have been grubbed up.

CLASS III.—GERMAN VARIETIES GROWN AT WYE SINCE 1902.*

Sample 1.—†" *Stirn.*"—Vigorous and fairly fruitful ; hop large, coarse, often leafy. Very early hop. (Hops when ripe infested with *Aphides.*)

1910.—" No characteristic German flavour ; has rub " (Factor D).

Sample 2.—†" *Halladau.*"—Vigorous and fairly fruitful ; hop large, often leafy. Early hop.

1910.—" No characteristic German flavour ; has rub " (Factor D).

Sample 3.—Variety from Hersbruck, near Spalt.

1910.—" Has retained some of its German flavour, but lacks rub " (Factor D).

Sample 4.—A late variety, name unknown, (between 302-3).—Vigorous and fruitful ; very late hop. Hops not quite ripe when picked, and damaged by " mould."

1910.—" Has retained some of its German flavour, but lacks rub " (Factor D).

Sample 5.—A late variety, name unknown (between 126-7).—Vigorous and fruitful, very late hop. Hops with touch of " mould."

1910.—" A good hop ; would rank with the best Fuggles " (Factor D).

* For the soft resins contents of these hops see the table at p. 467.

† indicates that a sample of this hop was submitted to Factors in previous seasons (see this *Journal*, Vol. XIX., p. 372.)

Sample 6.—A late variety, name unknown (between 264-5).—
Vigorous and fruitful ; very late hop.
1910.—" Inferior to Sample 5 " (Factor D.)

CLASS 4.—OREGON HOPS GROWN AT WYE SINCE 1908.

Ref. No. F 20.—Very vigorous and fruitful ; laterals very long ; hop long, pale.
Very late hop. (Hops not quite ripe when picked on Sept. 22nd.)
1910.—" Has pronounced Oregon flavour, though through hops being ill-developed and unripe, this is not so strong as in Oregon-grown samples ; also a distinct change can be detected from the original Oregon flavour into one inferior and 'beastly,' almost 'tallowy' " (Factor A) ; " has the genuine Oregon flavour, but ill-developed and unripe " (Factor B).

In the last *Journal* I wrote : " With regard to the production of resins, systematic investigations have now been begun. It is proposed to test for resins each season a large number of seedling and other hops growing in the College experimental hop-garden, as well as samples from the best growths of the year of English and foreign varieties obtained from factors and merchants. The chief aim in breeding hops must be to raise new varieties of strong constitution—suitable for different soils—and producing hops with a good aroma and high resin content. The determination of the percentage of resins in the various seedling and other hops grown at the College will be of valuable assistance in ascertaining the *real* value of any new 'seedling' hop, and also in deciding which are the best plants from which to breed."

During the season of 1910 a large number of dried samples of " seedling " and other hops growing in the College garden, and also samples of English and foreign hops obtained from factors and merchants, were analysed by Mr. R. H. Carter, in the College chemical laboratory, and their soft resin content determined by the method of analysis described by Mr. Carter in the last number of this *Journal* (Vol. XIX, p. 375).

Table Showing Percentage of Soft Resins.

Class I.—Hops of Unknown Parentage; believed to be Seedlings.

Ref. No.	A. Per cent.	B. Per cent.	Average. Per cent.
A2	10·14	11·73	10·94
B7	10·07	8·61	9·34
B9	9·27	8·70	8·99
B10	10·62	12·04	11·33
B14	11·41	9·53	10·47
B18	10·51	8·98	9·75
B20	8·04	9·42	8·73
C1	13·65	10·96	12·31
C5	6·48	7·14	6·81
C13	12·38	11·84	12·11
D8	8·00	7·96	7·98
D9	7·79	6·53	7·16
E14	10·94	12·10	11·52
F1	8·62	8·77	8·70
F21	8·85	9·50	9·18

The characteristics of the above hops are given under their reference numbers at p. 456.

CLASS II.—SEEDLING HOPS OF KNOWN PARENTAGE.*

Ref. No.	A. Per cent.	B. Per cent.	Average Per cent.
G21	12·43	11·69	12·06
H1	7·91	8·15	8·03
H3	10·12	10·03	10·08
H4	10·07	10·52	10·30
I4	10·36	11·52	10·94
I6	8·44	8·10	8·27
I9	11·05	11·63	11·34
I10	10·16	10·84	10·50
I16	9·26	9·94	9·60
I21	10·92	10·98	10·95
No. 11	10·50	11·07	10·79
No. 19	11·07	10·81	10·94
No. 21	7·80	7·28	7·54
No. 38	6·85	7·69	7·27
No. 49	9·48	8·95	9·22
No. 53	11·02	10·27	10·65
No. 54	9·70	9·73	9·72
No. 76	7·96	8·78	8·37
No. 125	8·70	8·62	8·66
No. 138	12·72	13·57	13·15
No. 152	10·90	11·13	11·02
No. 193	11·21	10·57	10·89

* The characteristics of these hops with regard to flavour and condition are given above at p. 459.

Class III.—German Varieties of Hops Grown at Wye since 1902.*

Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Stirn ..	10.18	10·89	10·54
Halladau ..	13·64	14·28	13·96
Hersbruck, nr. Spalt ..	11·10	10·55	10·83
A late variety, name unknown (Ref. No. 126-7) ..	10·64	11·73	11·19
Ditto (Ref. No. 264-5) ..	14·11	14·28	14·20
Ditto (Ref. No. 302-3) ..	11·09	12·08	11·59

Class IV.—American Variety grown at Wye since 1908.†

Variety.	A. Per cent.	B. Per cent.	Average. Per Cent.
Oregon "Cluster" ..	9·89	9·95	9·92

Class V.—American Varieties (grown in America).

Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Oregons (Independence) ..	12·19	11·39	11·79
,, (Eugene) ..	11·69	11·61	11·65
,, (St. Paul's District) ..	10·84	12·18	11·51
,, (Grant's Pass) ..	11·18	9·74	10·46
,, (Locality unknown ..	11·35	12·26	11·81

* The characteristics of these hops with regard to flavour and condition are given above, at p. 463.

† For characteristics as regard flavour etc., see p. 464.

CLASS VI.—GERMAN VARIETY (grown in Bavaria).†

Variety.	A. Per cent.	B. Per cent.	Average. Per cent.
Holledaus (Marzill) ..	13·51	13·27	13·39
,, (Holledau district) ..	14·62	13·50	14·6*

CLASS VII.—ENGLISH VARIETIES.†

Variety.	A. Per cent.	B. Per cent.	Average Per cent.
Fuggles (from Kent) ..	12·22	12·42	12·32
Goldings (East Kent) ..	10·83	10·53	10·68
Canterbury Whitebine (grown at Wye College) ..	10·63	10·42	10·53
Ditto ditto ..	10·29	9·33	9·81
Worcesters ..	12·12	13·29	12·72

Reviewing the above Table, we may note the very interesting fact that of all the samples analysed those richest in soft resins (14.20 per cent.) were produced by a German variety, the name of which is unknown, which has been growing in the experiment l hop-garden at Wye since 1902. (See p. 467, Class III., *Ref. No.* 264-5). The variety is a very late-flowering hop; of vigorous growth and a good cropper, with rather large, but not coarse hops. The samples were fairly

† These samples were supplied by Factors or Merchants as illustrating "the best growths of the year."

* In 1909 the samples of Holledaus analysed gave the very high average of 17.08 per cent. of soft resins. In a letter from Messrs. Wigan, Richardson & Co., they state: "The 1910 growth of Holledaus was distinctly inferior to that of 1909, which was a short crop of excellent quality."

well seeded. It is, however, doubtful if it is not too late-flowering to be quite suitable for our climate. The sample was submitted to a merchant well acquainted with the best German and English hops (see p. 464, Class III.), and the report was as follows: " inferior to Sample from *Ref. No.* 126-7," which was another plant of a very late-flowering German variety (probably identical) and which received the report, " a good hop; would rank with the best Fuggles."

The samples next highest in resins with 14·06 per cent., were Halladau hops grown in Bavaria. These hops were practically seedless. It is interesting to find that close to these came a sample of the Halladau variety from plants grown at Wye since 1902, with 13·96 per cent. of soft resins.

The only other hop to touch 13 per cent. of soft resins was a seedling hop, raised from Fuggles (*Ref. No.* 138), which has received a good report from factors (see p. 460), but which, so far, has not shown promising cropping powers.

Samples which showed over 12 per cent. of soft resins were the following:—

(1.) and (2.), Commercial samples of Worcesters, with 12·72 per cent., and Fuggles (from Kent) with 12·32 per cent., both representing " the best growths of the year."

(3.) A hop of unknown parentage (*Ref. No. C* 1), believed to be a seedling, which in 1909 stood out (with another hop noted below, *Ref. No. B* 10) as having a higher percentage (13·12 per cent.) than any of the other " seedlings " (see this *Journal*, Vol. XIX., p. 379). This year there was a wide difference between the duplicate samples, due no doubt to the fact that the hops were when ripe infested with *Aphides*. It is a hop which is undoubtedly rich in resins; it receives a good report from factors, but the hop itself is rather too small to become a favourite with the grower.

(4.) A seedling (*Ref. No. G* 21) raised from the Colegate hop, with 12.06 per cent. of soft resins. This hop has excellent cropping powers, and receives on the whole a good report from factors. It must be considered a hop of some promise, and is worthy of trial in different soils. In 1909, however, the samples averaged only 10.29 per cent. of soft resins.

(5.) A hop of unknown parentage (*Ref. No. C* 13), believed to be a seedling, with 12·11 per cent. of soft resins. This

received a mildly encouraging report this season, although last season the factors' reports were ambiguous, and the samples that year averaged only 8·54 per cent.

The following samples showed over 11 per cent of soft resins:—(1.) A hop of unknown parentage (*Ref. No. E* 14), believed to be a seedling, with 11·52 per cent. This is a very vigorous and fruitful hop, with a very red bine. The factors' reports are not very promising (see p. 459; also last *Journal*, Vol. XIX., p. 370).

(2.) A hop of unknown parentage (*Ref. No. B* 10), believed to be a seedling, with 11·33 per cent. of soft resins. In 1909 this hop came first of all "seedlings" with 13·95 per cent. It received a distinctly good report from the Borough.

(3.) A seedling (*Ref. No.* 152), raised from the Canterbury Whitebine variety, with 11·02 per cent. of soft resins. This plant is young, and may not have developed yet its true characteristics; it has received an ambiguous report from factors.

With regard to Class V. (p. 467), we may note that the samples of Oregons which were analysed showed a lower percentage of soft resins than those analysed in 1909. Most of them however, are distinctly rich in soft resins, with well over 11 per cent.

The Oregons grown at Wye (Class IV.) gave only 9·92 per cent. of soft resins. This is accounted for by the fact that this variety is so late-flowering under English conditions, that its hops do not ripen properly.

One other "seedling" hop may be noted, as it has points of special interest. This is the hop mentioned on p. 462 and p. 466, under the *Ref. No. I* 10. The female parent was the German variety, Saaz; the male parent, an English red-bined, early-flowering male hop. The factor's and merchant's reports, given above at p. 462, are very interesting, showing as they do that this seedling, raised in 1904 by Mr. A. Howard, from a German variety grown at Wye since 1902, produces hops with a distinctly German flavour. The amount of "condition" in the hops was commented on by factors and merchants. The plant is only fairly fruitful in the medium hop soil at the College; it is hoped that the cropping powers of this hop will be tested in other soils in Kent and Surrey.

The actual sample analysed did not give a high resins content (10.50 per cent.), but the hops at time of picking were infested with *Aphides*.

2·—The sending out of Male Hops to Growers in Kent and Surrey.

During the winter of 1910-11, several hop-growers in Kent and Surrey took advantage of the offer made by Wye College to supply them, free, with a limited number of "cuts" of selected male hops from which to raise a stock of suitable plants. For the first time the demand for male hops exceeded our supply at the time. Twenty-one applicants—hop-growers in Kent and Surrey—have been supplied with 1,384 "cuts" of selected male hops, chosen to flower at the particular time when the hops among which they were to be planted would be in "burr." Late- and early-flowering and mid-season males were asked for, and were supplied from the seventy-three male hills already established in the College experimental hop-garden. Over 100 hills of selected male hops are now being grown, and when all these are well-established it is expected that the requirements of all applicants will be able to be met.

It is gratifying to find that hop-growers generally are now convinced of the correctness of the view put forward in this *Journal*, Vol. XVII, p. 365, that the presence of a sufficient number of suitable male hops in the hop-garden is a point of primary importance.

As mentioned in last year's "Report" (see this *Journal*, Vol. XIX, p 385), stations have been established in Kent,—with the co-operation of certain growers, for the purpose of ascertaining the effect of soil, aspect, etc., on the time of flowering and on various other characters of different kinds of male hops. In addition to the 1,384 "cuts," mentioned above, which were sent out to commercial hop-growers, 442 "cuts" of selected males were sent out during the winter of 1910-11 to stations already established at Selling, Ashford, Dover, Tenterden, Ash, Paddock Wood and Ashhurst, and to fresh stations established at Rochester, Brenchley, Faversham, Rainham, Horsmonden and Midhurst.

Hop-growers who intend to apply for male hops should note carefully the period during which the hops among which the males are to be planted remain in " burr." If this information is sent to Wye College, exactly suitable varieties of male hops can be supplied.

VETERINARY NOTES.

DISEASES OF SHEEP, ETC.

"STRUCK SHEEP."

FURTHER TRIALS OF PREVENTIVE TREATMENT.

By T. W. Cave, F.R.C.V.S.

In the trials of the dosing method of treatment carried out in 1910, the dosing was not completed until February 19th. As the results, already recorded in the *Journal* of 1910, proved to be unsatisfactory, it was thought that better effect might be produced by dosing at an earlier period. As was shown in the last report, the greatest mortality occurs during March and April, and any preventive treatment adopted must provide protection for these months at least.

In the trials carried out during 1911, the dosing was begun on December 22nd, 1910, and was finished on January 10th, 1911. Between these dates, 450 sheep, the property of Mr. A. Finn, received two doses of virulent culture of the "struck" bacillus.

The dosing was completed five-and-a-half weeks earlier than in 1910.

The dosed sheep were distributed by Mr. Finn on land known to be dangerous, and were mixed with an equal number of undosed sheep. Owing to difficulties of keep, thirty of the dosed sheep were later removed, together with an equal number of undosed.

The records received in July accounted for the deaths from "Struck" in the 420 dosed and 420 undosed sheep, from March 1st to the end of June.

The number of "struck" sheep in the dosed and the undosed lots was exactly equal, eleven in each, or 2.6 per cent.

This result confirms the conclusions arrived at in 1910, "that this method of preventive treatment has failed to produce any beneficial effect." It is therefore necessary to abandon the method finally.

It is interesting to note the fact that during 1908-9-10-11, 2,797 sheep were dosed, each receiving not less than 10 *c.c.* of virulent culture by the mouth. Not a single death occurred which could be attributed to the dosing, yet it has been shown that 5 *c.c.* injected into the leg will produce death from " struck."

In 1908 255 sheep were dosed; the results proved to be uncertain, as the number of control sheep (undosed), owing to movements, could not be obtained. In the last three years careful records have been kept of 2,216 dosed sheep and 2,518 undosed. The number of " struck " sheep in the dosed lot was 53, equal to a percentage of 2.4. The number of " struck " sheep in the undosed lot was 63, equal to a percentage of 2.5.

These figures amply confirm the conclusions to which I have come, and I am compelled to admit that no reliance can be placed on the dosing method of preventive treatment. I have entered upon these details as to figures because the records for the past four years reveal several instances in which small lots of dosed sheep seem to show a decided advantage in favour of the treatment. It is only by examining the records of a sufficiently large number of dosed and undosed sheep that one can realize the uselessness of the treatment.

Some progress has been made in the preparation of a vaccine to be used hypodermically, but it will be necessary to submit the vaccine to a prolonged trial before any conclusion can be arrived at as to its protective properties and its safety.

JÖHNE'S DISEASE OF CATTLE AND SHEEP.

By T. W. Cave, F.R.C.V.S.

This disease was first discovered by Jöhne in 1895, and is now attracting considerable attention in this and other countries. The Board of Agriculture has recently instituted enquiries throughout Great Britain to discover the amount of disease in cattle and sheep.

It is a disease which is now known to be due to a bacillus (Jöhne's) which attacks the lining membrane of the intestine, causing a chronic inflammation and much thickening of the mucous coat.

" On post-mortem examination the lesions are found to be confined to the bowels and the surrounding lymphatic glands. The mucous membrane of the small intestine is seen to be very much thickened, in some cases it may be three or four times the normal. It is thrown into characteristic folds or corrugations, and may show areas of congestion. The large intestine and cœcum often present the same lesions. The affected glands are enlarged and œdematous, but show no caseation. . . . The presence of an acid-fast bacillus, not to be distinguished microscopically from the tubercle bacillus, in the thickened mucosa of the bowels of cattle suffering from chronic diarrhœa, was first shown in 1895 by Jöhne and Frothingham, who considered the condition to be a form of tuberculosis, and with them Koch was in agreement." (F. W. Twort, M.R.C.S., L.R.C.P. London, and G. L. Y. Ingram, M.R.C.V.S.)

In the *Journal of Comparative Pathology and Therapeutics* for March, 1907, M'Fadyean first called attention to the presence of the disease in Great Britain, and stated that it appeared to be comparatively common among cattle.

In the Annual Report of the Board of Agriculture and

Fisheries for the year 1909, Stockman described lesions, found in the intestines of a sheep, in which acid-fast bacilli, indistinguishable from those found in Jöhne's disease, were present in large numbers. Again in 1911, Stockman recorded his discovery of the disease in other sheep.

M'Fadyean has also found the disease in a deer.

The writer of this article has information of the existence of the disease in cattle in Kent and Surrey, but has no knowledge of its presence in sheep.

It is thought desirable that flock-masters should be made acquainted with the possibility that sheep may suffer from it, and any information on the subject will be gratefully received here.

Although the disease was at first regarded as a form of tuberculosis, it is now well established that inoculation tests on experimental animals have failed to produce lesions of tuberculosis, and that the disease is not tuberculosis.

Cases have been recorded in which animals suffering from the disease have reacted to the tuberculin test, but it is probable that such animals have suffered from both diseases at the same time.

In Jöhne's disease the symptoms consist of a gradual loss of condition followed by a chronic diarrhœa and emaciation. As these symptoms are similar to those seen in parasitic gastritis it is fair to suppose that mistaken diagnoses may be made owing to this resemblance, and it will in future be necessary to examine the intestines as well as the fourth stomach of cattle and sheep before forming an opinion as to the nature of the disease.

Infection probably takes place through the alimentary canal in all cases, as diseased animals will discharge immense quantities of infective material with the fæces, and it is easy to understand how food, water or pasture, may easily become contaminated.

The disease is usually slow in its progress, and under favourable conditions affected animals may live several months or even for nearly a year before extreme exhaustion and death occurs.

Cows frequently develop symptoms of the disease soon after calving.

Treatment does not appear to be of much value, although temporary improvement is said to follow the administration of suitably diluted antiseptic agents.

Prevention at present is most difficult, as there is no means of making an early diagnosis, and when the full symptoms develop the animal has for some time been distributing infective material about the farm.

It is hoped that a means of testing animals for the presence of this disease may ultimately be discovered, so that diseased animals may be removed from a herd before they have become dangerously infective.

Attempts are now being made to prepare a diagnostic vaccine to be used in a similar way to tuberculin, but so far unsuccessfully.

Until quite recently Jöhne's bacillus could not be cultivated in the laboratory, but now that Messrs. Twort and Ingram, of the Brown Institute, have succeeded in preparing a suitable medium, its culture has become possible, and in time no doubt a sufficiently strong vaccine will be prepared for diagnostic purposes.

DISEASE OF THE URINARY ORGANS OF RAMS AND RAM LAMBS.

By T. W. Cave, F.R.C.V.S.

Several outbreaks of disease of the urinary organs have been investigated during the past year.

On post-mortem examination the bladder has been found to contain a large amount of crystalline gravel, deposited from the urine. This gravel, on analysis by Mr. R. H. Carter, was found to consist of phosphates of calcium and magnesium. In some cases blood-stained urine was found in the bladder and the kidneys were deeply congested and much softened. The urine contained a large quantity of albumen. On microscopical examination of the urine many prismatic crystals were seen.

These lesions have only been seen in rams, ram-lambs and wethers, and not in ewes, or ewe-lambs, although animals of both sexes have been living together under the same conditions.

In all cases examined it has been found that the affected sheep have been highly fed on a rich nitrogenous diet together with mangolds, grass and hay, and there has been a more or less complete deprivation of drinking water. As is well known, sheep, living largely on grass or other green foods, do not consume much water, but where they are highly fed on cake, beans, oats, gram, etc., they will require a good supply of water, even though they may have also roots and grass. It is also possible that a dry season, in which grass would contain comparatively little moisture, may help in the causation of the condition above described.

The disease appears to be due to high-feeding and insufficient supply of drinking-water. The urine becomes highly charged with phosphates, derived from the food, both corn and mangolds, and the phosphates of calcium and

magnesium are deposited in the bladder and urethra, so producing the gravel, which is liable to block up the long and narrow male urethra, causing a difficulty in passing the urine or even a complete obstruction. The disease of the kidneys seems to be of a secondary character due to the obstruction of the urethra or in some cases of the ureters.

At first sight one might think the inflamed condition of the kidneys was caused by the highly concentrated urine acting as an irritant to the glands, but this is disproved by the fact that only males are known to suffer in this way, although both sexes may live under the same conditions. In the female the urethra is very short but comparatively wide and offers no difficulty for the escape of the gravelly deposit from the bladder, whereas in the long male urethra obstruction easily occurs.

Prevention will consist of an immediate change of diet, from a liberal supply of rich artificial foods to a more natural one of fresh green fodder and a plentiful supply of pure drinking water.

PARASITIC GASTRITIS IN SHEEP AND CATTLE.

By R. C. Bruce Gardener, B.A.

An investigation was opened in July 1911, into the serious losses which had occurred throughout the country among sheep, known to be due to the presence of certain nematode worms in the abomasum, or fourth stomach.

In the late winter and spring of 1911, the losses were very severe indeed, on some farms as many as fifty sheep dying within a few weeks. From July, however, up to the end of February, 1912, the investigation had met with but little success, on account of the lack of material upon which to work. In contrast to the great number of sheep which died in the spring of 1911, since July only four sheep had been received at the College suffering from this disease. The disease seems to have become dormant, this being due, possibly, to the dry summer of last year, for whereas in Huntingdonshire, for example, as many as 460 sheep had died out of a total of 2,600 between December, 1910, and the end of May, 1911, enquiries made in that county in October last failed to reveal a single case of the disease.

It is very probable that the embryos of these worms can withstand several months of extremely hot and dry weather, such as was experienced last summer, for it is known, as will be shown later on, that such is the case with the embryos of the lung worms, which are fairly closely related to the stomach worms. A wet autumn following on a dry summer seems to cause the disease to break out again, for very serious losses have been occurring among sheep in the west and southwest of England since last December. In one case, ninety-five sheep died out of a flock of 160.

I may take this opportunity of expressing my thanks to Mr. E. Granville Haskell, M.R.C.V.S., of Taunton, who has sent us, during the past five weeks, over a dozen stomachs of sheep which had died in his locality, without which the work here would have been seriously handicapped. My thanks are also due to Mr. W. C. Hazelton, M.R.C.V.S., of Buckingham, for sending the stomachs of two yearling heifers which had died there recently.

WORMS CAUSING PARASITIC GASTRITIS IN SHEEP AND CATTLE.

The animals responsible for this parasitic gastritis, originally known as "Lincolnshire Lamb Disease," belong to the class Nematoda, of the phylum Nemathelminthes, and although spoken of as worms, yet have no connection with the worms proper, or Annelids.

There are very many species of them known, some being common to both sheep and cattle. They have a very wide distribution over the surface of the earth, being met with in almost every sheep rearing country, and are found parasitic in very many wild deer and antelopes.

The species found during the investigation here belong to three distinct genera, and are as follows :—

GENUS HAEMONCHUS.

Haemonchus contortus.

(Rudolphi 1803) Cobb, 1898.

(Fig 1.)

Strongylus contortus.—Rudolphi 1803. "Neue Beobachtungen über die Eingeweiderwurme." (*Archmf. Zool. u. Zoot.*, v. 3, p. 1-32).

Strongylus placei.—Place 1893. Vet. Rec. Lond., v. 5. Apr. 22nd. p. 589.

Haemonchus contortus.—Cobb 1898. "Extract from MS. report on the Parasites of Stock." (*Agr. Gaz.*, N. South Wales, Sydney, V. 9. (3) Mar., p. 296-321. (4) Apr., p. 419-454.)

HOSTS.—Cattle, *Sheep, Goat.

LOCATION.—Fourth stomach, and intestine.

DISTRIBUTION.—Europe, United States, Asia, Africa, Australia, New Zealand, South America.

GENUS OSTERTAGIA.

Ostertagia ostertagi.

(Stiles 1892). Ranson 1907. Circular 116, Bureau of Animal Industry, Washington (Fig. 2).

Strongylus convolutus.—Ostertag 1890. " Ueber eine neue, strongylus-art im Labmagen des Rindes vorlaüfige mulheilung." (Centralbl. f. Bakteriol u. Parasitenk, Jena. V. 8. Sept., p. 457-460.)

Strongylus ostertagi.—Stiles 1892. " On the presence of Strongylus ostertagi in America." (J. comp. M. & Vet. Arch., N.Y., V. 13. (3) Mar., p. 147-148.)

Strongylus sp. Harker 1893. *Agric. Student's Gaz.*, Cirencester. N.S., V. 6.

Strongylus harkeri.—Stodter 1901. " Die strongyliden in dem Labmagen der gezähmten Wiederkauer und die Magenwurmseuhe. (Deutsche Fleischbeschaner-Ztg., Berl.)

HOSTS.—*Cattle.

LOCATION.—Fourth stomach.

DISTRIBUTION.—Europe, United States, New Zealand.

Ostertagia circumcincta.

(Stadelmann 1894). Ransom 1907. Circ. 116, Bureau of Animal Industry, Washington. (Fig. 3.)

Strongylus circumcinctus.—Stadelmann 1894. Sitzungst. d. gesellsch. naturf. Fv; Zu. Berl., p. 142-146.

Strongylus cervicornis.—McFadyean. 1897. " Parasitic gastro-enteritis in sheep and lambs." J. comp. Path. & Therap. Edinb. & Lond., V. 10. Mar. 31st, p. 48-63.

HOSTS.—*Sheep, Goat.

LOCATION.—Fourth stomach and small intestine.

DISTRIBUTION.—Europe, United States, New Zealand, Australia.

GENUS TRICHOSTRONGYHIS.

Trichostrongylus extenuatus.

(Railliet 1898). Ransom 1907. Circ. 116. (Fig. 4).

Strongylus gracilis.—McFadyean 1896. " Verminous Gastroenteritis in Cattle." J. comp. Path & Therap., Edinb. & Lond., Mar. 31st, p. 314-320.

Photo] [*F. Edenden.*

Fig. 1.
Haemonchus contortus. (Rudolphi).
Bursa of male × 70.

Photo] *F. Edenden.*

Fig. 2.
Ostertagia ostertagi. (Stiles).
Bursa of male × 200.

Photo] *F. Edenden.*

Fig. 3.

Ostertagia circumcincta. (Stradelmann).

Bursa of male × 175.

Photo] [*F. Edenden.*

Fig. 4.

Trichostrongylus extenuatus.

(Railliet)

Bursa of male × 250.

Photo] [*F. Edenden.*

Fig. 5.

Embryo of *Ostertagia circumcincta* (?) from fourth stomach of sheep. The specimen measured 1 5 millimetre in length.

Strongylus extenuatus.—Railliet 1898. (S. gracilis, McFadyean renamed.)
Strongylus retortaeformis.—Zeder of Stödter, 1901a, pp. 69, 75, 76.
HOSTS.—*Cattle. *Sheep, etc.
LOCATION.—Fourth stomach.
DISTRIBUTION.—United States, Australia, Europe.

The above accounts are taken from Bulletin 127, of the Bureau of Animal Industry, United States Department of Agriculture, Washington, by Dr. B. H. Ransom. An asterisk against a host denotes that one has personally found the parasite in question in that host.

LIFE-HISTORY OF THE NEMATODES.

One is constantly coming across articles in the daily papers, wherein it is stated, with reference to these worms, that in order to safeguard flock-owners against deaths among sheep, a second or intermediate host must be looked for, and steps be taken to remove this second host from the pasture.

As pointed out previously, the lack of material, until quite recently, for this investigation, has given very little opportunity for making experiments upon the life-history of the worms, but fortunately from observations made upon a few stomachs of the infected sheep which arrived here at the end of February, one is in a position to suggest, though not to prove conclusively, that in the case of some species, at any rate, the development of the worm may become complete without the necessity for a second host.

One of the specimens in question was the stomach of a yearling lamb, which had died near Taunton. Adult worms of the species *Ostertagia circumcincta* and *Trichostrongylus extenuatus* were present. The females of these were very full of eggs. Eggs in several stages of segmentation were found, and also eggs in which the vermiform embryo could be plainly seen, moving about within the "shell." Embryos in several stages of growth were seen moving about (see Fig. 5) on the slide, and finally immature males and females, the latter with no trace of eggs in them. Thus in one sheep were found all stages of the development of the worm from the newly

produced egg, to the adult. In the case of the eggs and embryos, however, it was impossible to determine to what species they belonged. In several cases all these stages were observed. The above facts, while they do not prove that a second host is non-existent, at least suggest that when the complete life-cycle can take place within one animal, there is no conceivable necessity for a second host.

Again, in the case of a sheep which had died at Deal, the wall of the stomach was covered with small red nodules, which, on being squeezed out on to a slide, were found to contain live embryos. Adults of the species *Ostertagia circumcincta* were found present in the fluid contents of the stomach. In the case of *Haemonchus contortus*, it has been shown by Dr. B. H. Ransom (Circular 93 of the Bureau of Animal Industry) that this worm undergoes a direct development without an intermediate host. "The eggs passed in the fæces of the host hatch in a few hours, days, or weeks, according to the temperature. Dryness or a freezing temperature kills the eggs and newly-hatched larvæ in a short time. The newly-hatched larva has an œsophagus with a posterior bulb containing a masticatory apparatus, and it feeds upon the fæcal matter in which it lives. Within a few days or weeks, the length of time required varying according to the temperature, the larva develops into the final free-living stage, which has a simple claviform œsophagus without interior bulb. In this stage the larva is closely enveloped by a thin chitinous sheath, and apparently is no longer able to ingest food, depending for its nourishment upon material stored up in the cells of the intestine. The ensheathed larva is motile at temperatures above 40° F., and becomes more active as the temperature becomes higher. Unlike newly hatched larvæ and eggs, the ensheathed larva can withstand freezing and dessication for long periods, and may survive several months in the dried condition, afterwards reviving on the addition of moisture. When the air is sufficiently damp for moisture to be precipitated as dew or rain, the ensheathed larvæ crawl up grass blades or other objects, coming to rest when the moisture evaporates, and resuming their migration when the air again becomes damp, and thus gradually work their way higher and higher from the ground. When

swallowed by a sheep or other ruminant, the ensheathed larva continues its development toward maturity, and becomes a full grown adult in two or three weeks."

Even though in some cases the whole by the life-cycle may take place in the body of one animal, it is very probable that some eggs will pass out in the fæces, and undergo development on the grass in the way described for *Haemonchus contortus*.

Symptoms.

The following account of the symptoms by Professor T. W. Cave, F.R.C.V.S., is taken from the S.E.A.C. *Journal* of 1908.

There is a gradual loss of condition, the animals becoming thin and weak, without any other signs of ill-health in the earlier stages, except perhaps an occasional attack of diarrhæa.

In the later stages, a remarkable paleness of the skin and mucous membranes may be seen, after which the animal rapidly becomes so weak that it can move only with great difficulty. The appetite is now entirely lost, œdematous swellings appear about the submaxillary space, throat and dewlap, the wool falls off, leaving large areas of bare skin, the animal becomes incapable of rising, and death soon follows.

Prevention.

It has been a common practice among farmers to take sheep from a pasture known to be infected by stomach worms, and to rest the pasture for some months by grazing it with cattle. It has, however, been shown already that each of the worms *Haemonchus contortus* and *Trichstrongylus extenuatus* are common to both sheep and cattle. It is therefore at once obvious that if an infected pasture has held sheep, not only must sheep be kept off that pasture, but cattle also, and goats. For while cattle do not suffer as severely as sheep do from the effects of these particular worms, they nevertheless serve, by forming a host for the embryos coming from sheep worms, to keep the disease alive, instead of allowing it to die out. Horses and pigs, which do not harbour these parasites, may be safely put on the pasture. Sheep and cattle should be kept out of such pasture for at least a year, for the embryos of the worms can withstand several months very dry weather. One came across a striking case of the long

drought which Nematodes can withstand in a laboratory experiment made here. Early in February of last year, the embryos of the Lung Worm (*Strongylus rufescens*) were placed on some dry sand in a covered petrie dish. The dish was placed in a perfectly air-tight glass vessel and kept in a hot room. On the night of July 31st, *i.e.*, five-and-a-half months later, a small piece of damp blotting paper was placed on the sand, and the whole covered up again. The next morning, a microscopic examination of the sand revealed the embryos still alive, and moving vigorously. The damp blotting paper was then removed, and the dish and sand dried again in an incubator. The next damping took place on October 10th, when the embryos were again found to revive after a few hours. Total duration of drought was eight months. If embryos of the lung worm can withstand such prolonged drought, and under strict artificial conditions, it is highly probable that the embryos of stomach worms can survive on the grass for even longer than eight months, when not very long would elapse without rain.

Method of Obtaining the Parasites.

The contents of the fourth stomach are poured into a basin, the stomach wall being well scraped at the same time. If a glass rod be dipped into the fluid, and transferred to a beaker of clear water, and stirred round, a fair indication of the number of parasites in the stomach may be obtained, as sometimes one dip of the glass rod will bring up as many as thirty worms, a number which would point to the cause of death being due to the very great number being present in the stomach. (Method adopted by Professor T. W. Cave, F.R.C.V.S.). Occasionally a stomach will be found to be empty of fluid, and scraping the "leaves" will reveal no worms. In such cases, the presence of any grit in the stomach will point to there having been worms there recently.

The fluid in the basin is now poured into a tall jar, and sedimented with plenty of water. In a few minutes, the worms fall to the bottom, the water is poured off, and the sediment shaken up with more water. This operation is repeated several times until the mass of worms is washed fairly clean. The same result is also obtained by pouring the fluid

into a jam jar, over the top of which a piece of fine muslin is tied. The jar is placed under a slowly running tap, until all the coloured matter is washed out through the muslin, leaving the clean sediment at the bottom of the jar. This latter method is adopted by Professor T. W. Cave.

Small masses of the residue obtained by either of the above methods are picked up by a pair of forceps, and put into a beaker of clear water. The worms fall slowly to the bottom of the beaker, and are caught, as they fall, on a needle. Both male and female of *Haemonchus contortus* are easily recognised by the naked eye. This is of necessity a tedious method, if it is wished to collect a large quantity of worms, but it is one which is sure of obtaining them free from foreign matter.

Method of Mounting the Worms for Examination.

The worms obtained free from foreign matter in the way described in the last paragraph, should be placed in dilute glycerine (about 40 per cent.) and left for, say, twenty-four hours. They can then be safely put into stronger glycerine, without fear of their shrinking, and finally mounted in pure glycerine.

It is absolutely no use putting the worms into formalin, unless very dilute (about 2 per cent.) Formalin shrivels them beyond recognition, nor are staining methods of any use.

By the glycerine method, one obtains beautifully clear specimens, with very little, or no, shrinkage.

Another method which is very successful, is that described by Dr. B. H. Ransom, in Bulletin 127, Bureau of Animal Industry, Washington, and is as follows: "The worms are killed in hot, nearly boiling, 70 per cent. alcohol, to which may be added, if desired, 5 per cent. of glycerine, or 10 per cent. if the worms are small and readily permeated by the killing fluid. To prepare them for study, the specimens may then be placed in a mixture of twenty parts of absolute alcohol and eighty parts of carbolic acid, which renders them sufficiently transparent for examination in temporary mounts under the microscope."

If it is wished to collect eggs and embryos as well as the adult worms, the safest method is to pour the freshly collected

stomach fluid without washing, into hot alcohol and glycerine, as described in previous section. Washing, either by sedimentation, or by the muslin method, will result in eggs and embryos being lost.

Method of Examining Fæces for evidences of Parasitism.

The following method is that described by Maurice C. Hall, in Bulletin 135 of the Bureau of Animal Industry, U.S. Department of Agriculture, Washington. One has not had much opportunity for trying it, but on the few occasions on which it has been used here, it has served very well to separate out the nematode eggs. It seems to be the most certain, and in many ways the simplest, method of detecting traces of parasitism in the fæces of sheep and cattle.

The fæces are shaken up very thoroughly in a wide-mouthed glass bottle about three-quarters full of water, fitted with a rubber stopper. It is necessary to crush up very thoroughly such hard fæcal masses as those of sheep, before putting them into the water. After having been completely broken up by shaking in the bottle, the fæces are poured through a set of six brass sieves. The sieves used here were made to order by Messrs Flatters & Garnett, of Manchester. They are three inches in diameter, resting one on top of the other, and range from a mesh-aperture of $\frac{1}{12}$ inch in the upper to $\frac{1}{100}$ inch in the bottom one. The set of sieves is placed in a large evaporating dish, and the fæces poured into the top, *i.e.*, the coarsest, sieve, into which is also poured tap water, which is allowed to run through the set of sieves until it stands in the evaporating dish at a level above that of the bottom of the upper sieve.

This top sieve is lifted and shaken, so that all fine matter can pass through, and is then placed in a separate dish, and washed thoroughly, the matter being kept aside later for examination. The same operation is repeated for each of the sieves.

The matter finally left in the dish after the removal of the finest sieve, is poured through another brass sieve, having a mesh-aperture of $\frac{1}{120}$ inch, into a tall glass jar, and is sedimented with plenty of water. After decanting, the sedi-

ment is placed in a beaker, and again washed. The entire sediment is then centrifuged, repeated centrifuging with the addition of fresh material adding to the total of centrifuge sediment, and may be washed again at this point.

" After the material in the two centrifuge tubes is washed in water, one tube is left alone ; the water is poured off the other, and calcium chloride solution with a specific gravity of 1·250 is added to the sediment. After centrifuging, a slide preparation is sometimes made from this tube direct. In most cases the top cubic centimeter is pipetted off, shaken up with fourteen cubic centimeters of water, and centrifuged. By means of a long pipette, a drop of sediment is drawn up from the bottom of the tube in which water alone is used, placed on a slide under a cover glass, and examined under the microscope. A second slide is made from the other tube. This second slide is either made directly from a drop taken from the surface of the calcium chlorid solution, or from the bottom, in case the top cubic centimetre has been added to water and centrifuged. The second slide is used as a check on the first. It sometimes has fewer eggs, especially if made from the sediment where the top cubic centimetre of the 1.250 solution has been centrifuged with the addition of water, and occasionally throws additional light on the material under examination. The pipettes are rinsed thoroughly, and when dried, are heated in a Bunsen flame for a short time to destroy any eggs that might adhere, thus preventing contamination in subsequent examinations."

The above is but a very brief abstract of the original paper, to which reference should be made for further technical details. The section between inverted commas, however, is copied verbatim from the original.

Localities.

In the last eight years (*i.e.*, since May, 1904) the disease has been observed at the following places in Kent and Surrey :—

Kent.

(*a*) Due to *Haemonchus contortus.*

Birchington	Wye
Larkfield	Woodchurch
Sissinghurst	

(*b*) Due to *Ostertagia circumcincta.*

Sheppey
Yalding
Teynham
Tilmanstone
Deal

Surrey.

Shalford.

LOCALITIES.

Huntingdonshire.

Very serious losses occurred in this county during the early months of 1911. The most serious outbreaks were reported from the following parishes ; an asterisk denoting a mortality of over 20 per cent.

Alconbury, Monks Wood.
*Alconbury, Weston.
Alconbury, Weybridge.
*Barham.
Connington.
*Easton (40 per cent.).
Eynesbury.
Godmanchester.
*Kimbolton.
Kimbolton, Wornditch.
Keyston.
Raveley, Little.
Staughton, Gt.
*Stoneley.
Stukeley, Gt.
Toseland,
*Waresley.
Wintringham.

LOCALITIES

Somersetshire.

I am indebted to Mr. E. Granville Haskell, M.R.C.V.S., of Taunton, for the following list of localities in which have occurred serious outbreaks of parasitic gastritis among sheep. In each case the loss was very much over 20 per cent.

West Monkton.
Lydeard St. Lawrence.
Broomfield.
Halse.
Brompton Ralph (in one case 57 per cent.)
Cothelstone
Kingston (in one case 78 per cent.)
Staplegrave (in one case 89 per cent.).

Mr. Haskell says that the greater part of West Somerset has been affected, and a good part of North Devon.

Worms Parasitic in the Fourth Stomach of Cattle.

In April, 1909, a very serious outbreak of parasitic gastritis occurred among bullocks at Brackley, in Northamptonshire.

In the stomachs of some of these cattle *Ostertagia ostertagi* was found in abundance, and associated with it was found a worm which was thought at first to be the male of *Ostertagia circumcincta*, but which Dr. B. H. Ransom, to whom the specimen was sent, suggests is a new species. The material from these stomachs had unfortunately been preserved in formalin, which had seriously shrivelled the worms, with the result that only one good specimen was obtained. On March 12th, one received from Buckingham the stomachs of two yearling heifers which had died in that locality. Each of these was found to contain both *Ostertagia ostertagi* and *Trichostrongylus extenuatus*, the latter worm being also parasitic in the sheep. Previous outbreaks of this cattle disease occurred in 1907 at Horsham, in Sussex, and Lympne, in Kent, in both cases due to *Ostertagia ostertagi*.

One has not personally come across *Haemonchus contortus* in cattle, but the fact that both cattle and sheep harbour both the worms *Haemonchus contortus* and *Trichostrongylus extenuatus* cannot be ignored. It is a fact of the greatest importance to farmers, as it sets at nought the old idea of giving an infected pasture a rest from sheep by grazing it with cattle. Such a procedure is almost as fatal as leaving the sheep on it perpetually, as it serves to keep alive the disease, which would have a reasonable chance of dying out if both cattle and sheep were kept off the pasture for *at least a year*.

Giving the pasture an absolute rest in this way, will probably be far more effective in the long run than any amount of dosing-treatment of the infected individual.

GENERAL NOTES.

GENERAL NOTES.

DISTRIBUTION OF PRIZES, SESSION 1910-11.

THE RIGHT HON. VISCOUNT MILNER, G.C.B., G.C.M.G., ON AGRICULTURAL NEEDS.

The annual distribution of prizes and diplomas took place on Friday, October 6th, the awards being handed to the successful students by the Right Hon. Viscount Milner, G.C.B., G.C.M.G., who presided. Lord Milner was supported by Lord Ashcombe (chairman of the Board of Governors), Mr. H. E. H. Rice (Chairman of the Finance and Farm Committees), Messrs. J. Sayer, J. D. Maxted, J. E. Quested, and H. Fitzwalter Plumptre (Governors), and Mr. M. J. R. Dunstan (Principal of the College). The gymnasium, in which the distribution took place, was filled by a gathering which included visitors from various parts of the counties of Kent and Surrey.

In opening the proceedings the Principal said he was glad to be able to report that the past year had been satisfactory. They had had successes and they had had disappointments, and, as at all times in the history of the College, they had received the attention of critics. He sometimes thought of himself and the College as being very much in the position of the man and his ass in Æsop's fable (laughter), although he meant no reflection on the College when he likened it to that useful animal (renewed laughter). If they followed the advice of all their critics they would become, like the ass, perfectly stagnant (hear, hear). They were glad to have criticism,

but the one thing he asked was that those who criticized what they had done should first learn what actually had been done. When a man criticized a figment of his own imagination it was apt to be difficult to convince him that what he imagined was not actually taking place at the College (hear, hear). Continuing, Mr. Dunstan said the number of students had increased, one hundred and sixty having passed through during the year, while the quality of the work done was superior to that of former years. Numerous appointments had been obtained by students at home and abroad, in Government service, as scientific experts, and in various land offices. There had been changes in the staff. They had lost Dr. Goodwin, one of the most distinguished agricultural chemists, who had become Principal of the Midland Agricultural College ; and also Mr. McDonald, who, after endearing himself to them all, had left to take up important work in the Soudan. Mr. Eames had gone from Wye back to a former Principal of Wye to take charge of the Rothamsted experimental farm. He (the speaker) was glad to say that they had an increasing number of students farming in the immediate neighbourhood of the College, and proving the practical value of the knowledge obtained there (applause).

With regard to the work of investigation, they had been as active as possible. Experimental work and digestibility trials with new feeding stuffs had occupied their attention, and important work had been done in connection with "struck" sheep, and numerous parasitic diseases. In the hop and fruit department they had been particularly active and numerous trials with new varieties had been carried out, as well as experiments in the cultivation of tobacco, while Mr. Salmon had been very energetic and successful in pursuing mycological investigations. To carry on the work they required increased accommodation. The number of appeals for advice which they received was constantly increasing, and it was impossible for them to give advice unless they were enabled to work on the problems upon which they were always being consulted. He was glad, therefore, that the Governors had decided to enlarge the College buildings. He was sorry to have to record the sad death of Mr. Charles Buxton, son of Mr. Sidney Buxton, the President of the

Board of Trade, and one of the most original and promising men who ever came to Wye. Another misfortune was a serious accident to Mr. Burgess at his home near Godalming, but he was glad to learn that although his recovery was slow there was some hope of its being complete.

The Board of Agriculture had recognised that their work was deserving of support by increasing their grant from £1,000 to £1,300 (applause). As they were all aware, the season had been a very difficult one for the farm, but he was happy to inform them that they were sharing the prosperity of the hop-growers. Coming from the past to the present, he said that a record number of students had entered, 140 (including 57 new men), compared with 120 a year ago, and the number from the contributing counties of Kent and Surrey was 69. Mr. Dunstan also mentioned that they had received an additional grant from the Board of Agriculture for experimental work with tobacco, sugar beet and fruit, and spoke of the importance of the forthcoming Kent fruit show. Looking forward to the future, he felt that they were on the threshold in the matter of agricultural education and research, and expressed the opinion that Wye would play a prominent part in the work that would be done. He also referred with pleasure to the proposed establishment of an experimental fruit orchard in Kent. His concluding words on the College and its work were to the effect that they were in a state of flourishing vitality. They could look back on the past with satisfaction, and look forward to the future with great hope (applause).

In introducing Lord Milner, Mr. Dunstan spoke of the right hon. gentleman's triumphant success in the agricultural development of South Africa, and mentioned that he was assisted by Mr. F. B. Smith, whose former association with Wye College as Vice-Principal and Farm Director was well known.

Address by Lord Milner.

After distributing the prizes and diplomas, Lord Milner said that addressing the company present was for him the least enjoyable part of the proceedings. He realized that he was speaking to a body of experts on a subject of which he did

not profess to have any considerable knowledge, either theoretical or practical. He supposed they would treat his observations with the becoming indulgence usually given to a sympathetic outsider and well meaning ignoramus (laughter). They might, however, be certain that any opinions expressed by him were not concocted for the occasion, but were merely the expression of ideas which he had long held, and which he had gathered in the experience of his life in different countries.

One thing which he felt very strongly was that the British nation had a great deal to expiate and to atone for in its treatment of agriculture in the recent past. He did not suppose there was any civilized country which had, as far as public policy was concerned, so neglected what we still on every occasion kept describing as our principal industry. Public men were always paying compliments to it, but, with rare exceptions, they had all conspired to do nothing for it. It had been said that that was the natural and necessary consequence of great industrial and commercial development, but he could not admit that for a moment. He held that agriculture had in the immediate past—during the last two generations—been wantonly and ignorantly sacrificed in this country. Many of the evils which they all agreed in deploring, in their economic and social conditions, had their root in that single fact, and when he saw that other countries, by no means behind them in industrial development, or if behind, rapidly gaining upon them, found it possible to give an amount of attention and encouragement to agriculture which the State in England until quite recently, had not done, then he realized how great was the fallacy that the one thing necessarily conflicted with the other. No doubt there was a great improvement in quite recent days—something like an awakening of the public conscience with regard to the neglect of the past ; but it would have to go a good deal further if it was to wipe out the reproach under which they had laboured in this respect and which was illustrated by the fact that there was no other great civilized country anything like so dependent for its food supplies on imports from other countries. He knew there were many explanations, but he did not think any of them justified the calm acquiescence of the community in that rather damning fact.

An institution like that, the existence of which was a proof of the awakening of the public conscience, was called upon to play a great part in the work of reparation. There were many aspects of that movement, but the one for which the College stood was the development of the more scientific side of agriculture—in increasing the productivity of the soil. In the old pre-scientific days the farmers of Great Britain feared no comparison with those of any other country. That was true, even to-day, of the best of them—(hear, hear)—but he was not quite so sure that it was as true as it used to be of the average. In these days, when the old type of farmer, who was a farmer by tradition and instinct, who had farming in his blood, was becoming rarer, it was true of farming as it was of every other industry, that success rested more than ever on the practical application of science. As regarded agricultural science the record of this country was in some respects quite a good one. Our Universities, especially Cambridge, had a world-wide reputation for agricultural science and research.

There had always been and were individual citizens who by extraordinary munificence had shown what could be done for agriculture in all its branches by the most advanced methods, but if an impartial visitor from Mars were to make a farming pilgrimage of European countries he would hardly give the palm for the general level of scientific agriculture to Great Britain. He did not wish to reproach the farmers. The British farmer might well say, " What encouragement has our industry ever had to make progress ? " It was not a reproach to the farmers, but it was a reproach to the nation (cheers). From statistics, he was convinced that the total agricultural output was nothing to be proud of. It was a fascinating inquiry as to how far it could be advantageously developed—how far it could be done and how far it would pay to do it. Obviously by the employment of a large amount of capital they could get an enormously greater quantity out of the land. The question was whether that was the best employment for a large amount of capital. His opinion, based on a fairly careful study of results, was that the people who thought that this country could be made very nearly or very much more nearly self-supplying, and that it would

pay to make it so, were not nearly so wild as they were commonly supposed to be. In this matter the men with the greatest imagination and the broadest views would meet with the most successful results.

They heard a great deal of discussion about capital being driven out of the country, and certain people whose consciences were not very easy as to their responsibility in driving it out—(laughter)—were constantly trying to show that the export of capital was good for the country. He was not such a fool as to condemn the employment of British capital in foreign countries. A great deal of it so employed did, for a time at least, add to the work here in other directions. He still remained, however, unregenerately convinced that a great deal more capital was required in this country. He did not rejoice in the export of capital which was needed here (hear, hear). To him it was evident that there was a great deal of land in this country crying aloud for the investment of more capital, as it did for the application of more labour, and he did not think that, on the whole, taking a broad view, and not looking merely at the narrowest individual interests, there was any branch of industry or enterprise in which a great deal of capital could be more advantageously employed than in agriculture.

Although he had been speaking of the opportunities before scientific farmers in this country, he did not ignore the fact that in that place their horizon was not confined to these islands, and that they looked upon the whole British Empire as a field in which to exercise their abilities. That aspect of the work appealed very much to him. He might be wrong about the amount of room for scientific agriculture in this country, but he was sure he could not be wrong about the enormous opportunities that lay before the trained agriculturist in other parts of the Empire. The trained agriculturist, the man who had acquired the scientific attitude of mind, the competent man with energy who went to any of our Overseas Dominions, could never, unless he was very unfortunate, fail to have a successful career. Let them not think that they would go out as missionaries to teach unlearned barbarians the rudiments of knowledge (laughter). That was not, by any means, the case. The great dominions, especially

Canada, had great agricultural institutions of their own. In the encouragement given to agriculture they put the Mother Country to the blush. Even the Cinderella of the self-governing Dominions, poor South Africa, had been falling into line owing to the ability and energy of an old vice-principal of that institution (cheers).

His own connection with Mr. Smith had already been mentioned by Mr. Dunstan, and he would recall it in order that they might not think what he had been saying was entirely in the air. He (Lord Milner) was as ignorant as could be on agricultural subjects, but he was called on once to take over a country over which a great war had swept and had just levelled everything perfectly flat. He was the last to think a new broom was always the best broom, but what he then felt was that inasmuch as there had been this clean sweep there was an excellent opportunity to restart, not where people before the war had left off, but at the highest level which any science, and trained assistance they were able to command, could start them at. Therefore his efforts were entirely directed from the first to starting at the highest level scientific agriculture had attained by means of such men as they could get to go out and show them the way. They were severely criticized by all " practical " men, and some impolite reflections were made on his personal ignorance of what he was doing. He knew he was ignorant, but he got hold of a principle which saved him from the usual consequences of ignorance, and, leaning heavily on the crutch offered to him by the scientific knowledge of other people, he did succeed, or, rather they did succeed, in restarting agriculture in South Africa on a level which had received the commendation even of those who were not originally favourably disposed to their efforts (cheers).

They must not think that in carrying their trained ability to other parts of the Empire they were going among people in any way backward, yet they were going to countries with such ample opportunities that no man with ability and energy was ever likely to fail. He was thinking not only of the self-supporting Dominions, but also of the Dependencies—East Africa, West Africa, and others—which had a very great future of agricultural development before them. He regarded as

the greatest of all public objects which could be before Britons at this time the drawing closer of the ties which united, or ought to unite, the scattered dominions of our Sovereign in all parts of the world. Proposals to that end were manifold, and some were highly controversial. He did not think they ought to be ; he thought that was a mistake and a misunderstanding, but there was one kind of link which they would all agree in regarding as desirable—that which arose from the exchange of men, and led to a growing sympathy of ideas between different parts of the Empire. Regarded from that point of view, any man who carried his trained ability from here to exercise it in one of our great dominions or dependencies was not only carving out for himself a promising career, but was helping to strengthen the ties between the younger and the older countries, and to increase the solidarity of Greater Britain (applause).

For the services which an institution like that could render both to the nation and to the Empire it was entitled to the greatest encouragement and support not only from the counties immediately benefited, but from the nation and the Government. He would always do all in his power to prod statesmen and to influence public opinion in the direction of a more active and forward agricultural policy by which he hoped that institution and the counties it immediately served might greatly benefit (loud applause).

Lord Ashcombe, as chairman of the Governing Body of the College, proposed a vote of thanks to Lord Milner. He said that it was a great privilege to hear his address that day and they hoped he would continue to show the kindly interest in the College which he had already manifested. In seconding the vote,

Mr. H. E. H. Rice re-echoed the sentiments expressed by Lord Ashcombe, and added that although the noble Chairman began his speech saying that he was not an expert, they could not forget that he had successfully organized the agriculture of half a continent, and organization was the first and last word in agriculture or any other business. The vote was accorded with acclamation, and Lord Milner briefly replied.

A vote of thanks to the Principal and Staff of the College, proposed by Mr. J. Sayer and seconded by Mr. J. E. Quested, closed the proceedings.

The awards were as follows :

Diplomas and Certificates.

Diploma with Honours.—S. Skelton (Agriculture), A. L. Tate (Agriculture).

Diploma.—G. E. Baxter, D. E. Baxter (Hon.), C. Boyle, J. V. Edge, H. C. L. Keable, F. W. Page-Roberts.

Certificate.—W. Adam,* R. B. Furley, P. G. Kibler (Hon.), H. E. Wright, J. S. Rutherford.*

Farm Certificate.—H. B. Parriss.

Horticulture Certificate.—S. Skelton, C. E. Dickinson,* G. C. Sankey.*

The following Students satisfied the Examiners.

Part II. of the Diploma.—P. A. Durlacher, E. J. Howard, E. A. C. Owen,* H. Rosher, J. E. Spickernell, B. P. Tuppen.

Part I. of the Diploma.—B. Allen, H. P. Borlase, A. H. Fairbairn, T. J. Gripper, F. S. Gregory, L. E. Holyman, J. C. Palmer, M. A. Waterer.

Part I. of the Certificate,—R. S. Cole, E. R. Garnett, E. A. Hulme, J. K. P. Patterson, R. M. Wilson.

The following satisfied the Examiners in the subjects named.

Part I. Diploma Standard.—C. W. B. Wright, Commercial Fruit Growing, Chemistry, Botany, Agricultural Zoology ; C. A. W. Duffield, Agricultural Zoology ; J. M. Templeton, Agriculture ; E. R. Warren, Agricultural Zoology, Veterinary Science.

Part I. Certificate Standard.—G. Peirson, Agriculture ; S. Scrimgeour, Agriculture, Veterinary Science, Agricultural Science ; E. R. McMaster, Veterinary Science ; B. G. D. Stopford, Agricultural Chemistry, Veterinary Science.

* Conditional.

Part III. Diploma Standard. G. O. Searle, Agriculture, Agricultural Chemistry, Agricultural Botany; T. D. Mosscrop, Agriculture, Agricultural Chemistry, Agricultural Botany.

First Term Men.—G. W. Hughes, R. H. Sharp, P. J. Carey, G. H. N. Balme, C. A. Fenwick, W. J. Frampton, H. K. King.

Prizes and Medals.

Degree Course Prize.—T. D. Mosscrop.

Diploma Prizes.

Third Year.—Agriculture, G. E. Baxter, F. W. Page-Roberts; Agricultural Botany, G. E. Baxter; Agricultural Chemistry, G. E. Baxter, *prox. acc.*, W. B. Barling.

Second Year.—Book-keeping, etc., P. A. Durlacher, *prox. acc.*, H. Rosher; Veterinary Hygiene, B. P. Tuppen, *prox. acc.*, H. Rosher, J. E. Spickernell, C. Maxted; Agricultural Entomology, B. P. Tuppen.

First Year.—Agriculture, B. Allen, *prox. acc.*, H. P. Borlase, A. H. Fairbairn, J. M. Templeton, M. A. Waterer; General Science, B. Allen, *prox. acc.*, M. A. Waterer.

Certificate Prizes.

Second Year.—General Certificate Work, J. S. Rutherford; Horticulture, S. Skelton, *prox. acc.*, C. E. Dickinson, G. C. Sankey.

First Year.—General Certificate Work, R. S. Cole, E. A. Hulme, *prox. acc.*, R. M. Wilson.

Special Prize.

The Agricola Prize for the best aggregate of marks in Third Year Diploma Work.—G. E. Baxter.

Medals.

Plans, etc., Farm Buildings.—P. A. Durlacher.

Poultry Management.—T. D. Mosscrop.

Practical Farm Work.—H. B. Parriss.

The Successes of Students in Outside Examinations were as follows.

B.Sc. Degree—Final.—J. H. Mattinson.
Intermediate.—L. A. B. Sharpe, G. S. Smith, C. E. Strickland, N. P. Chamney (referred in Botany), S. D. Timson (referred in Chemistry).

Surveyors' Institution. Professional Associate Examination —W. Adam, W. B. Barling, R. Edwards, R. A. Hay, P. G. Kibler, F. W. Page-Roberts, L. H. Pyke, A. L. Tate, W. T. Trench.

National Diploma, Dairying.—L. H. Pyke.

L. H. Pyke also obtained the Silver Medal in the Dairy Farmers' Association Examination.

SUMMER TEACHERS' COURSE.

This Course was held from July 31st to August 11th. Sixty-one Schoolmasters attended—thirty-one from Kent and thirty from Surrey.

Mr. S. T. Parkinson delivered a series of lectures on "Elementary and Advanced Plant Physiology" to the First and Second Year men respectively. Mr. H. P. Hutchinson and Mr. G. H. Garrad arranged the practical work, which was specially designed to suit school requirements. The First Year men took the usual course in Elementary Chemistry. A new course on "Poisons in Plants" was taken by the Second Year. The lectures in both courses were given by Dr. S. J. M. Auld. Mr. C. Hutchinson assisted with the practical work. Other subjects taken were "Bacteriology" by the Principal; "Entomology," by Mr. F. V. Theobald; "Mycology," by Mr. E. S. Salmon; "Poultry Keeping," by Mr. W. F. Snell, and "Vegetable Cultivation," by Mr. H. C. Chapelow.

The afternoons were devoted to practical demonstrations in Horticulture, Gardening, Land Surveying, Bee-keeping and Poultry-keeping. Popular lectures were given in the evenings by the Principal, on "Cellulose and its Uses," and by Mr. Garrad, on "Standard Bread." It was decided that the College Association of Kent and Surrey teachers should be conducted on the same lines as last year.

THE STATE CONTROLLED AGRICULTURAL SCHOOLS OF FRANCE.

D. R. Edwardes-Ker, B.A. (Oxon.), B.Sc. (Lond.).

The trend of modern general education is undoubtedly in the direction of centralization and the bringing of the different teaching centres throughout the country under one and the same control, as shown by the growth of the Board Schools and the many Technical Institutes in Great Britain, a large proportion of which are directly or indirectly under the supreme jurisdiction of the Board of Education.

In Agricultural Education the general movement seems to be in the same direction. Many Agricultural Colleges and Schools are already, at least, inspected by Government Officials, while the Farm Institutes that are to be founded shortly in a number of different counties will be largely controlled from headquarters.

The age of private ventures in the domain of education is on the wane, and schools and colleges run as money-making concerns by private individuals are slowly but surely being ousted from their position by the more technical state-controlled institutions.

Agricultural education in France has progressed much further than has England in this direction, and at the present day is vested almost entirely in the hands of the Government ; the few institutions still remaining which began their existence as more or less private concerns are being gradually absorbed by, and brought under the direct control of, the State, while in a few year's time an agricultural school unconnected with the Government will doubtless be regarded as a curiosity.

The writer was enabled to visit, during January, 1912, several of the State-controlled French agricultural colleges and schools which go to make up a complete and wide-reaching

system of State education, and the more salient points that were noticed with regard to the French methods of agricultural instruction are herewith given.

The list of centres supplying agricultural education in France is a lengthy and imposing one. Commencing with the famous *Institut Agronomique* in Paris, at which institution the highest and most specialized instruction and research work in agriculture and questions of agricultural importance in France is carried out, there follow the three large *Ecoles Nationales* at Grignon (Seine-et-Oise), Montpellier (Hérault) and Rennes (Ille et Vilaine) respectively, all of which are similar in many ways, both as regards method of management, courses of instruction and class of students, to the larger English Agricultural Colleges such as those at Wye and Cirencester.

The *Ecoles Pratiques* of which there are over forty in number, deal in the main with a different class of students, these being largely the sons of small working farmers and gardeners, who are thus enabled to secure for their sons a thorough practical training at a very slight expense.

To the same class belong about a dozen similar schools, which do not, however, confine their attention so largely to agriculture and horticulture proper, but which make a speciality in instruction in allied subjects, such as dairy products, horse breeding, sheep rearing, silkworm culture, and viticulture or vine growing, in those parts of the country where these industries flourish, and where there is thus a demand for special instruction in the various subjects.

The sixteen *Fermes Ecoles*, which deal with a lower class of students, are farm schools giving elementary instruction, both practical and theoretical, in agriculture and subjects allied thereto. These schools, which are the least important of all the agricultural institutions, are run on entirely different lines to the other centres of agricultural education, the students, mainly the sons of peasants, being to all intents and purposes apprenticed to the director of the school, who farms the land connected with it at his own risk, although at the same time he receives a small subsidy from the State to provide for the salaries of the staff and for other general purposes.

The number of these farm schools shows a steady decline of late years, in contradistinction to the increase in the number of Practical Schools, and this must doubtlessly be taken as an indication of the growth of State control, at least in this department of education.

It may be taken, therefore, that there are three distinct grades of agricultural instruction in France, namely the Practical Schools (*Ecoles Pratiques*), the National Schools (*Ecoles Nationales*), and the highest form of agricultural education and research represented by the single example of the *Institut Agronomique* in Paris. It must not be thought, however, that these different grades are kept severely separate, and as a matter of fact, it is the rule rather than the exception to find the most successful students of the Practical Schools entering the National Schools as scholars, and finally obtaining further state assistance to enable them to pursue their studies at the *Institut Agronomique*: the courses of instruction are eminently adopted to allow of this progressive promotion from a lower class of institute to a higher, and it may in fact be said, without leading to any great misconception, that the three classes of agricultural education are dovetailed and consecutive and may be represented by (1) practice (2) practice combined with theory and (3) advanced theory and research.

The *Ecole Pratique* at Antibes (Alpes Maritimes), which was one of those visited, may be taken as a representative example of the practical schools.

Founded by ministerial decree in 1891, the school professes " to produce agricultural managers, and capable gardeners, possessing all the theoretical and practical knowledge relative to their art, and to give a good professional instruction to the sons of agriculturists, proprietors, or farmers, and, in general, to young men destined for an agricultural career." Special mention is also made of the fact that the instruction given should be regarded as a preparation for those who desire to enter one of the *Ecoles Nationales*.

Here are both internal and external students, and the fees are respectively £20 (Frs. 500) for board, lodging and tuition, or £2 (Frs. 50) for tuition alone, per annum. A certain number of state scholarships, providing free instruction, board and lodging for a period of three years, are also open for com-

petition by examination, and are awarded annually only to those students whose parents are unable to entertain the expense of the course. In addition, all students who are not scholars have to submit to an entrance examination, as the number of the places in the school are limited.

The age limit is from fourteen to eighteen years, and at Antibes there are thirty-six students, while the courses of theoretical and practical instruction, which are most comprehensive and from a rigorous practical standpoint, are in the hands of nine professors, all of whom are, naturally, paid state officials.

The farm and gardens, of a total area of about twenty acres, are worked entirely by the students under the supervision of the professors and two gardeners, and the main crops of the district, including, in addition to the ordinary farm crops, early cut flowers, orange flowers, oranges, grapes, tobacco, olives, as well as the ordinary vegetables, are sold under strictly practical conditions at the various towns in the neighbourhood.

There is only one course of study, extending over a period of three years, with one session per year commencing in the middle of September, with a few days vacation at Christmas, and four weeks in the summer, although naturally all the students are not allowed to be absent at the same time. In addition to yearly examinations, there is a final examination at the end of the course, the successful candidates being placed in order of merit. To the successful candidates are delivered official state certificates, carrying with them the right to a certain number of points in the examination for entrance scholarships at the *Ecoles Nationales*.

Of the *Ecoles Nationales*, the largest, oldest and best known is that at Grignon, and the writer was fortunate enough to be able to pay a visit to this institution during the middle of the session.

Founded during the Empire in 1831 as an agronomic station and agricultural school, there are now in residence 117 students, mostly of the upper middle class, excepting for those that have graduated from the Practical Schools. In the extensive laboratories, up-to-date farm buildings in the private grounds of an old château, 200 acres of arable land,

and 35 acres of pasture, this school differs markedly from the more modest Practical Schools.

Sixty-two of the students are internal, are admitted by examination only, and pay £48 (Frs. 1,200) per annum inclusive for board, lodging and tuition ; the limited number of forty external students live out of college, are not required to pass any entrance examination, and pay an annual fee of £16 (Frs. 400), while there are fifteen so-called " free " students (*auditeurs libres*) paying a sum of £8 (Frs. 200) per year, but who are entitled to attend the practical courses only, and have not the right to enter the laboratories nor to attend lectures. Students of nationalities other than French are admitted according to either of the two latter systems.

A sum of £400 (Frs. 10,000) is awarded in the form of scholarships each year, while ten places carrying with them complete remission of all fees are reserved annually for deserving students.

In every case the length of the course is three sessions, commencing in the middle of October, and ending in the middle of July, with a few days vacation at Christmas. In this way a certain number of the more important summer operations on the farm, such as haymaking, are each year carried out in the vacation during the absence of the students, and a change is at present proposed, although it has not yet come into force, whereby the course of all the students for a certain year will be so modified as to remedy this defect, by requiring them to be in residence during the summer vacation.

The mornings are devoted to lectures and laboratory work, while in the afternoons practical classes are taken round the farm. In addition to weekly examinations in different subjects there is also in force a system of " weekly services " applicable to students between the middle of their second and third years, whereby gangs of three or four students are required to take entire charge of, and to perform all the work attached to one of the departments of the farm, as for example, the stables, the cow-house, the pigstys, the implements, for three days in each week, working on a system of rotation, so that by the middle of the final year all the students have had practical personal experience in every department of farm work. This

system appears to work successfully, and is said to render it unnecessary for the students to serve some time on a farm after the completion of their college course. A feature of the practical instruction is the frequent visits made by classes of students to different farms in the neighbourhood, and also to various breweries, distilleries, sugar refineries, flour mills and dairies situated around or in Paris, and which are thus sufficiently near to allow of ready access.

The laboratories, museums, and lecture rooms at Grignon are on an almost extravagant scale, and are not in the form of one block of buildings, but are erected separately in different parts of the park. The implement shed is a colossal structure, and contains many hundreds of implements, most of which, however, are out of date, and are agricultural curiosities rather than of practical value. The library, containing an extensive collection of books and periodicals, is open to students only during the hours of attendance of the librarian.

A certain number of students from Grignon, Rennes and Montpellier pass each year into the *Institut Agronomique*, either with or without scholarships, of which there are ten offered per annum of a yearly value of £40 (Frs. 1,000), and ten carrying a right to entire remission of fees.

There is no agricultural station or college in England exactly comparable to this *Institut*, which is situate in the centre of Paris, and serves as headquarters from which a large amount of experimental and research work carried on at different farms in the environs is directed. The object of the *Institut* is to produce men suitable for positions as Principals and professors at the different State schools, directors of agronomic stations, agricultural engineers, managers of breweries, distilleries, etc., and undoubtedly provides an advanced and highly specialized education in all subjects connected with agriculture.

There is one other School in France differing in certain respects from any of the above and worthy of a short description.

The *Ecole Nationale* of Horticulture at Versailles resembles somewhat the Practical Schools, but is on a much larger and more ambitious scale. With twenty professors, and eighteen acres of highly-cultivated gardens in the immediate vicinity

of Paris, the school provides *free* instruction to one hundred and twenty students in all the more important horticultural and market garden subjects, especially the production of trained ornamental fruit trees, in which the French are so skilled.

The students are not resident in the school, but provide their own board and lodging ; ten scholarships of a value of £40 (Frs. 1,000) per annum are, however, open for competition, while the majority of students entering the institution already hold exhibitions offered by their various schools or departments. The gardens are on the site of the old kitchen garden of the Royal Palace at Versailles, and the staff are proud of the fact that owing to the excessive richness of the soil, no artificial or other manures are ever required. It is a question, however, whether working under such ideal conditions does not tend to produce a too optimistic outlook on the part of the students.

The general conclusions to be drawn as to the methods of agricultural education in France are as follows. Very complete courses are given at numerous institutions throughout all parts of the county, in all branches of agricultural subjects, from elementary practice to advanced theory and research, and a hardworking student of an intelligence slightly above the average should be able to follow the complete and graduated course with little or no personal expense, obtaining scholarships from one type of school to the next higher type.

This method of graduated education at different institutions is naturally only possible when the whole system of education is under one control, such as that of the state ; the usual failing of state management, such as excessive officialism and a liberal use of red tape, are not so conspicuous as one would be led to believe, although they are always present to a certain extent ; this, however, may be forgiven when it is remembered that practically free instruction is now provided for those classes of students who could least afford to pay for it, and one must not be blind to the great advantages that have resulted from the system, as evidenced by a very general raising of the standard of agricultural education throughout the French Republic.

WEATHER REPORT, 1911.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS AT THE SOUTH-EASTERN AGRICULTURAL COLLEGE, WYE, KENT, DURING THE YEAR 1911.

Compiled by D. R. EDWARDES-KER, B.A., B.Sc., from observations by H. C. CHAPELOW.

	Temperature.									Rainfall.				Sunshine.					
	Mean Daily.			Highest in Scrn.	Lowest in Scrn.	Lowest on Grass.	Number of Frosts.		Soil Temp. at 3 ft. at 9 a.m.	(Inches). Total.	(Inches). Greatest fall.	Date.	No. of Rain Days.	Total.		Maximum in one day.		Date.	Bar. Mean.
Month.	Max.	Min.	Mean.				In Scrn.	On Grs.						Hrs.	Mins.	Hrs.	Mins.		
Jan.	41.5	32.3	36.9	52	22	14	13	18	37.7	1.655	.66	11th	13	55	5	7	20	31st	30.40
Feb.	45.6	35.2	40.4	52	23	18	9	14	37.1	1.155	.26	27th	13	86	20	8	25	26th	30.20
March	47.2	37.3	42.2	62	30	24	6	14	39.0	2.585	.7	12th	16	90	40	10	30	28th	29.90
April	52.0	38.3	45.1	64	28	23	6	12	40.6	1.85	.4	4th	11	147	10	11	50	24th	30.08
May	64.7	48.0	56.4	79	32	25	1	2	48.0	.76	.34	13th	4	227	45	13	0	29th	29.99
June	64.7	51.4	58.0	82	35	30	nil	1	55.3	2.885	1.34	23rd	13	171	00	13	0	5th	29.96
July	76.8	54.0	65.4	90	40	37	nil	nil	58.9	.28	.23	29th	2	274	00	12	0	5th, etc.*	30.30
August	76.6	56.8	66.7	94	45	46	nil	nil	63.3	1.375	1.0	20th	4	247	40	12	0	9th, etc.*	29.90
Sept.	67.1	50.0	58.5	82	39	33	nil	nil	57.3	.96	.43	15th	5	†254	40	11	30	1st & 2nd	30.00
Oct.	56.5	44.7	50.6	67	32	28	1	5	51.0	5.00	.85	7th	15	111	30	8	45	6th	30.13
Nov.	48.1	39.0	43.5	57	25	21	2	12	45.0	4.48	.95	18th	17	51	35	7	20	1st	29.94
Dec.	47.4	37.2	42.3	53	29	25	5	13	41.4	6.92	1.09	10th	25	34	50	5	40	6th	29.90
The Year	57.4	43.7	50.5	94	22	14	43	91	47.9	29.905	1.34	—	—	1752	15	13	0	—	30.06

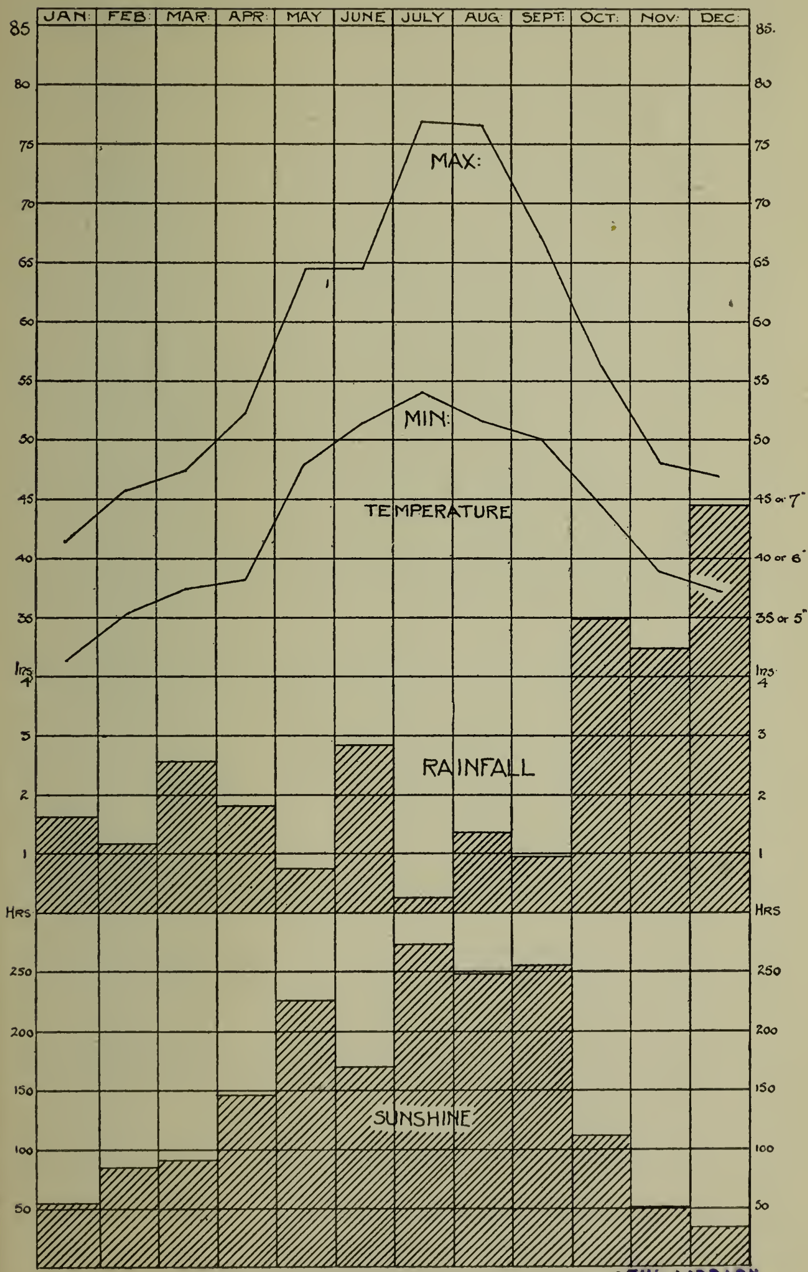
Notes to above Table.

Height of Station above Mean Sea Level, 150-ft.
Latitude, 51° 11′.
Barometric readings uncorrected for temperature and height above sea level.

Highest Reading of Barometer during year, 30.70 on Feb. 1st.
Lowest Reading of Barometer during year, 29.45 on Nov. 17th.
Highest temperature of Soil at 3-ft., 65.0.
Lowest temperature of soil at 3-ft., 36.0.
There were 80 days on which no sunshine was recorded.
† The sunshine records for September having been inadvertently destroyed, the figures given for the month are those recorded at Tenterden, and kindly supplied by J. Ellis Mace, Esq.

A Rain-day is one on which at least .01 inch falls.
*12 hours of Sunshine in July and August on the following dates: July 5th, 12th, 14th, 20th, 22nd, 23rd, 27th, 31st; August 9th, 12th, 14th, 15th.

CHART SHOWING IN GRAPHIC FORM THE FIGURES GIVEN ON THE PREVIOUS PAGE.



STAFF PUBLICATIONS.

By F. V. Theobald.

1. A New Culicid Genus (Newsteadina). *Annals of Tropical Medicine and Parasitology.* Vol. II. No. 4. February 1909.
2. Report on Economic Zoology for the Year ending September 30th, 1910. *Journal of South-Eastern Agricultural College.* pp. 83-211, and Figs 7 and Plates lvi. No. 19. 1910.
3. Springtails (Collembola). Their economic importance, with notes on some unrecorded instances of damage. *Memoires 1st Congress International d'Entomologie.* Vol. II., pp. 1-18. Plates i.-iii. Brussels, 1911.
4. The Distribution of the Yellow Fever Mosquito (*Stegomyia fasciatá*) and General Notes on its Bionomics. *Memoires 1st Congress International d'Entomologie,* pp. 145-170. Plate v. 1911, Brussels.
5. Fruit Tree Sprays and Spraying. *The Field.* No. 3033. February 11th, 1911.
6. Snow Flies (*Aleyrodidae*), pp. 4, fig. 1. *Leaflet No.* 12 *South-Eastern Agricultural College.*
7. A New Genus and two new Species of Culicidæ from the Sudan. *Fourth Report Wellcome Tropical Research Laboratories, Khartoum,* pp. 151-156, and 2 figs. (17 and 18), and 2 plates (x. and xi.), 1911.
8. Culicidæ of the Royal Zoological Society "Natura Artis Magistra" Amsterdam, and descriptions of three new species. *Overgedrukt uit het Tijdschrift voor Entomologie.* Decl. liv., pp. 233-240. Amsterdam 1911.
9. Novæ Culicidæ. Part I., April 1911, pp. 35 and figs. 21. Art paper, 3s. 6d. 1911.

10. Second List of the Aphididæ found in Kent. *The Entomologist.* xliv., November and December; and xlv. January 1911-12.

11. The Culicidæ or Mosquitoes of the Transvaal. *First Report of the Director of Veterinary Research* (Union of South Africa), pp. 232-272 and Plates i to xi. Pretoria 1911. 3s. 6d.

12. Culicidæ of the Seychelles. Percy Sladen Trust Expedition to the Indian Ocean in 1905. No. V. Diptera Culicidæ. *Transactions of the Linnean Society of London.* Vol. xv. 2nd Section, Zool. Part I., No. v., pp. 81-94. Figs 12, Pl. i. (4).

13. A new African Corethra. *Ann. Mag. Nat. Hist.*, Ser. 8, Vol. vii., pp. 399-400, 1911.

By E. S. Salmon, F.L.S.

1. Spraying Experiments with a Lime Sulphur Summer Wash. *Journal Board of Agriculture.* February 1911.

2. Lime Sulphur Wash. *Leaflet of South-Eastern Agricultural College.* May 1911.

3. Economic Mycology and some of its Problems. *Presidential Address to the British Mycological Society,* delivered at Taunton. September 20th, 1911.

4. On the Control of Apple Scab by Bordeaux Mixture and Lime Sulphur. Paper read at the First Kent Commercial Fruit Show, held at Ashford, December 11th, 1911. Reprinted in Local and Horticultural Press, and as *Leaflet of South-Eastern Agricultural College.*

By G. H. Garrad.

1. Tobacco Growing for Insecticidal Purposes. *Board of Agricultural Journal.* August 1911.

2. Report on the Growing of Tobacco for Nicotine Extraction. *Leaflet of South-Eastern Agricultural College,* pp. 262-317. No. 19. 1910.